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TOOLKIT FOR CLIMATE-RESILIENT WATER UTILITY OPERATIONS

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TABLE OF CONTENTS

ABBREVIATIONS

BP	business plan
CoP-CC	Community of Practice on Climate Change
COWD	Cagayan de Oro Water District
EAP	emergency action plan
ENSO	El Niño Southern Oscillation
EOC	emergency operations center
ERP	emergency response plan
FWCA	Florida Water and Climate Alliance
IPCC	Intergovernmental Panel on Climate Change
ISAWAD	Isabela City Water District
KPI	key performance indicator
LGU	local government unit
LMWD	Leyte Metropolitan Water District
lpcd	liters per capita per day
LWUA	Local Water Utilities Administration
m^3	cubic meter
MCWD	Metro Cotabato Water District
MIWD	Metro Iloilo Water District
mld	million liters per day
MO	Manila Observatory
NEDA	National Economic and Development Authority
NGO	non-governmental organization
NRW	non-revenue water
NWRB	National Water Regulatory Board
O&M	operations and management
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services

	Administration
PAWD	Philippine Association of Water Districts
PPP	public–private partnership
RCP	representative concentration pathway
UHI	urban heat island
VA	vulnerability assessment
ZCWD	Zamboanga City Water District

GLOSSARY OF TERMS

Adaptation cost is the capital expense required to implement an adaptation option (present value expense).

Avoided cost is the capital value of the damage that *will not occur* due to the implementation of an adaptation option. The avoided cost is used to reduce the capital cost and is critical to ranking options by priority. For example, relocating pumping equipment from a flood-prone area may avoid equipment repair or replacement cost.

Climate is an expression of the composite weather conditions (such as temperature, precipitation or wind), including both statistical averages and the occurrence of extreme events, over a given period of time. The World Meteorological Organization recommends a 30-year period to adequately describe the climate of a given area.

Climate change refers to a statistically significant variation in climate data or patterns over a given period of time, due to either natural climate variability or as a result of human activity.

Climate change adaptation describes measures taken in response to actual or projected climate change in order to eliminate, minimize or manage related impacts on people, infrastructure and the environment.

Climate change impacts on infrastructure are, for the purposes of this toolkit, the resulting influence of climate change effects on the structural form or function of a water supply system.

Climate change variability is the short-term fluctuation in weather conditions, usually over a period of a year or a few decades.

Exposure refers to the extent to which a system comes into contact with a hazard or threat.

No regret actions are cost effective measures under current and future climate scenarios that increase adaptive capacities and will have a positive impact on livelihoods and ecosystems without requiring trade-offs with other policy objectives.

Resilience, as defined by the Intergovernmental Panel on Climate Change, is the ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner, including through the preservation, restoration or improvement of its basic structures and functions.

Risk is the combined function of the likelihood that a hazard will occur and the resulting consequences.

Sensitivity is the degree to which a built, natural or human system is directly or indirectly affected by or responsive to changes in climate conditions or related impacts.

Threats are extreme climate or weather events that create impact or cause damage, such as flooding, wind or drought.

Urban heat island (UHI) effect is the warming phenomenon that occurs when the temperature of an urbanized area becomes significantly warmer than the surrounding rural area due to the heat-trapping ability of impermeable urban surfaces.

Vulnerability is the degree to which a system is susceptible to or unable to cope with adverse effects of climate change, including climate variability and extremes. It is often defined as a combined function of exposure and sensitivity to the effects of climate change, minus the adaptive capacity of a system.

PREFACE

This toolkit provides methodologies for a water utility to develop three documents that are essential to improve its climate resilience: a vulnerability assessment, a climate-resilient business plan, and an emergency response plan. These three documents and associated practices are interconnected and should be implemented holistically to achieve optimal climate resilience. These documents require regular updating and, in the case of the emergency response plan, strength testing through annual desktop exercises. This toolkit was written primarily for medium to large water utilities in the Philippines (locally called water districts), but it can be used by any medium to large water utility worldwide with adjustments to local circumstances.

The USAID Be Secure Project is grateful to the Philippine Association of Water Districts, which created the Philippine Community of Practice on Climate Change and participated in a twinning partnership with the Florida Climate and Water Alliance to increase climate resilience of Philippine water utilities. Six Philippine water districts participated in the twinning partnership: Leyte Metropolitan Water District, Cagayan de Oro City Water District, Metro Iloilo Water District, Isabela City Water District, Zamboanga City Water District, and Metro Cotabato Water District. The hard work and insights of their staff made the twinning successful and led Be Secure to develop this toolkit with the goal of enabling other water utilities to benefit from their experience. Be Secure consultants Maurice Tobon and Christopher Pettit provided excellent technical support to the six water districts and prepared this toolkit.

EXECUTIVE SUMMARY

The Philippines is one of countries most vulnerable to climate change impacts. For many parts of the country, a changing climate is expected to increase the frequency and severity of extreme weather events, accompanied by increasing pressure on water utilities to supply water to customers. In other locations, higher mean annual temperatures, lower mean annual precipitation, and increased frequency of droughts are expected to increase evapotranspiration from land and water surfaces, and water demand by communities. Even small changes in the timing and frequency of rainfall over time can change groundwater recharge patterns or filling/storage/discharge cycles of reservoirs.

Super Typhoon Yolanda (Haiyan) hit the Central Philippines at wind speeds in excess of 315 kilometers per hour on November 8, 2013, and was one of the most powerful typhoons in recorded history. More than 6,000 people lost their lives and damages were estimated in excess of $12 billion. The impacts on water systems left many without water for months, and included service line breakage, flooded and wind-damaged buildings and equipment, and landslides that buried water intake systems and disrupted operations at treatment facilities. The Leyte Metropolitan Water District, a government-owned and -controlled corporation that supplies potable water to Leyte's capital, Tacloban City, and seven municipalities, incurred costs of over PhP 9.2 million for repairs and retrofits due to flood and wind damage to water supply systems, and lost revenue of more than PhP 1.9 million.

Recognizing the need to improve the resilience of city water services to the risks of climate change, USAID/Philippines created the Water Security for Resilient Economic Growth and Stability (Be Secure) Project. The Be Secure Project was awarded on July 8, 2013, with a period of performance of four years, ending on July 7, 2017. Be Secure has two major, interrelated components to support water security in selected sites in the Philippines:

1. Increased sustainable access to water supply and wastewater treatment services; and
2. Increased resilience to climate-related water stress and hydrological extremes.

To meet these objectives in water security, Be Secure conducts activities that address national water sector reforms, as well as the provision of sustainable services at the local level. The project conducts training to increase the capacity of water service providers for sustainable delivery, disaster risk reduction, and climate change adaptation. Be Secure also helps water districts develop sustainable systems for water, weather and climate data analysis and exchange, and tailors that information to meet the needs of end-users for long-term water resources capacity.

The Philippine Association of Water Districts (PAWD) supports a Community of Practice on Climate Change (COP-CC) to improve the capacity of its member water districts on climate change adaptation and disaster risk reduction. The Be Secure Project engaged WaterLinks Management Council, Inc., to help build capacity of the CoP-CC and facilitate mentoring through the Florida Water and Climate Alliance (FWCA). FWCA members mentored the CoP-CC on vulnerability assessment and business planning. A series of workshops and site visits was held for six city representatives from the Isabela City Water District, Zamboanga City Water District, Metro Cotabato Water District, Cagayan de Oro City Water District, Leyte Metropolitan Water District, and Metro Iloilo Water District. Site visits to water system facilities were organized in Tacloban and Cagayan de Oro cities as part of the vulnerability assessment training.

As part of this capacity development activity, each of the six core members of the CoP-CC drafted a vulnerability assessment of their respective water utility. The work emphasized the need to prepare two important plans:

- **An emergency response plan** focused on the avoidance or minimization of damages, operations during emergencies, and recovery from hazards, and
- **A business plan** to finance the protection and risk reduction of water and sanitation infrastructure.

Be Secure worked with the water districts to develop these plans. The three guidance manuals in this toolkit are the outcome of this process.

The toolkit details steps for: (1) conducting vulnerability assessments to determine vulnerabilities within a water provider; (2) climate-resilient business planning that integrates priority projects and actions identified by the vulnerability assessment into the normal course of utility operations; and (3) the development and implementation of an emergency response plan to enable efficient and effective response to emergency events that may be exacerbated by climate change impacts. The toolkit integrates lessons learned from the COP-CC established by PAWD by featuring case studies throughout.

Vulnerability Assessment. A vulnerability assessment applies a process to identify, quantify and prioritize the weaknesses and vulnerabilities within a system. For Philippine water districts dealing with the impacts of climate change, vulnerability assessments integrate the examination of existing above- and below-ground infrastructure; identification of areas exposed to climate hazards; climatic impacts and consequent risks to the entirety of the system as a whole or in specified areas; and identification and prioritization of key projects necessary to upgrade, mitigate or adapt to climate change impacts.

BOTTOM-UP VULNERABILITY ASSESSMENT

Step 1: Identify historical operational disruptions to establish exposure and sensitivity

Step 2: Assess historical rainfall and temperature variation

Step 3: Project rainfall and temperature changes

Step 4: Estimate climate change impacts on water supply

Step 5: Identify potential water supply shortfalls

Step 6: Evaluate adaptation options

Step 7: Develop communications strategy

Step 8: Monitor and adjust

The vulnerability assessments will focus on consequences of climate change for both the water utility as well as the surrounding environment that provides the water resource. The assessments carried out by the six water districts in the Philippines identified the following most common climate-related hazards:

1. Extreme rainfall conditions that lead to flooding and increase in turbidity.
2. Low-flow conditions arising from drought or extended dry periods, which affect water supply.
3. Increased surface temperatures that can lead to algal bloom affecting water quality and increasing evapotranspiration.
4. Typhoons and storm surges that may affect water infrastructure and other assets.

Options were identified to reduce risk and impacts from these hazards, as well as improve capacity to manage future incidents.

The vulnerability assessment methodology in this toolkit is based on the bottom-up approach as is described in *A Tool for Coastal and Small Island State Water Utilities to Assess and Manage Climate Change Risk.*[1] This approach offers an intuitive, evidence-based path of eight steps to understanding climate change scenarios, impacts on operations and options for adaptation. The use of a bottom-up approach is simpler, requires less data, and is more suited for developing countries where limited data and difficulty in accessing data hinder the use of more complex methodologies used in a top-down approach.

For a complete discussion of vulnerability assessments, see Section 1.

Climate-Resilient Business Plan. Integrating climate resilience into a traditional business plan requires a balance between traditional capital, financial and operations needs, and climate resilience as prioritized in the vulnerability assessment. In incorporating the results of the vulnerability assessment into the business planning framework, water service providers must understand possible risks and consequences, and how much they will cost.

Climate-resilient business planning will help to determine an acceptable level of risk due to climate change impacts, reduce uncertainty, improve efficiency, provide a clear narrative for stakeholders, and allow for a basis to monitor and measure progress. This guide offers clear steps to develop a plan that is clear, reader-friendly, and can be utilized by public relations staff to undertake outreach efforts to generate further support for the water utility.

CLIMATE-RESILIENT BUSINESS PLANNING

Step 1: Prioritize projects identified in the vulnerability assessment

Step 2: Assess the current business plan for scope and limitations

Step 3: Develop SMART goals and objectives based on financial assessment

Step 4: Develop an expenditure plan to incorporate climate resilience into goals and objectives

Step 5: Develop an assessment process using key performance indicators to implement the plan

The business plan should identify funding and rate structures necessary to undertake projects prioritized by the vulnerability assessment and justify those projects within the scope of normal utility operations and responsibilities. Most importantly, it is an opportunity for potable water suppliers to lay out the climate-related challenges facing their locality and region, and the solutions being developed to mitigate and adapt to these challenges.

It is up to each water district to determine those risks with less disastrous consequences that may be considered as manageable by a utility or community, provided that affordable measures can be put in place to address them if they occur. Implementation of adaptive management through annual assessment and measures of success allows for continued growth and flexibility, as well as the ability to adjust if climate impacts are greater or lesser than anticipated.

[1] WaterLinks Global Water Operators' Partnership Alliance (GWOPA). *A Tool for Coastal and Small Island State Water Utilities to Assess and Manage Climate Change Risk* (WaterLinks GWOPA and UN Habitat, 2016).

For a complete discussion of business plans, see Section 2.

Emergency Response Plan. When an emergency occurs, the first priority is always to address life safety. The second priority is the stabilization of the incident impacts in order to minimize further risks to safety and damage to services. Even with a mature and effectively implemented business plan that incorporates climate resilience, there will be those emergency events that will test the responsiveness and capabilities of a water service provider. It is therefore essential for a utility to have a well-developed emergency response plan that will allow the entity to respond rapidly and effectively to all aspects of emergency events that affect water supply service delivery.

ELEMENTS OF THE EMERGENCY RESPONSE PLAN

1. Emergency planning information (contacts and logistics)
2. Water district information (technical specifications)
3. Emergency operations
4. Emergency action plans (who, what, where)
5. Response and recovery procedures
6. Updating and training staff

While an effective business plan will identify the essential resources for effective emergency response, the emergency response plan will provide the basic blueprint by which a water district deploys resources and manpower in response to an emergency event. The emergency response plan sets out detailed information regarding how the utility will act as a unified and coordinated team in the event of an emergency, what equipment will be used, and where. The plan should also include a process for damage assessment, disposal of damaged equipment protection of undamaged property, and cleanup following an incident. These actions will minimize further damage and business disruption, while allowing a potable water supplier to efficiently respond to its concessionaires to ensure that high-quality water service continues through an emergency event or is restored shortly after an emergency event if it is lost during the event.

The vulnerability assessment is also vital to the emergency response plan development process, as it is utilized to provide the basis for the identification of possible climate-related disasters, as well as anticipated changes in the severity of impacts as the effects of climate change become more pronounced (such as by longer droughts or heightened storm frequency). An emergency response plan should have a specific set of implementation criteria and action plans for each specified emergency event. They should always contain three parts: personnel procedures; facilities, equipment and materials procedures; and special/targeted notes and procedures.

High-risk events can be mitigated through the establishment of partnerships with other water districts to assist in times of need. For example, the emergency response plan should list those organizations that the potable water supplier collaborated with in developing the plan and who have agreed to provide support in an emergency. For example, a water district should identify the emergency operations division of an associated local or regional government entity and indicate how and when to communicate with the entity during an emergency event. Mutual aid agreements that have been executed between a water supplier and other parties can also be included in order to provide greater flexibility for immediate assistance that is reimbursable at a future date and time.

For a complete discussion of emergency response plans, see Section 3.

Lessons Learned. The procedures for the vulnerability assessment, business plan and emergency response plan outlined in this toolkit have been tried and tested by the six water districts receiving assistance through the Be Secure Project. Through this experience, the following lessons learned emerged:

1. The threat of climate change is real and immediate actions should be undertaken by water districts in order to adapt and ensure water sustainability.
2. Water districts must continue to assess vulnerability and re-evaluate planning approaches in light of climate change impacts and information.
3. Climate change considerations must be part of overarching strategic objectives for the water district.
4. A business plan helps to manage fiscal impacts of climate stresses and their corresponding adaptation measures in order for water supply services to attain financial viability.
5. Results of the vulnerability assessment must be linked to business plans and emergency response plans; it is important for business plans to incorporate and reflect approaches to climate change adaptation.
6. Incorporating vulnerability assessment results into existing business plans often requires adjustment of the original financial strategy and management approaches.
7. It is often difficult to foresee all possible impacts of climate change. Water districts can work together to share their experiences of climate change impacts and approaches to maximize the effectiveness of climate-resilient business plans and emergency response plans.

It is important to remember that the vulnerability assessment, climate-resilient business plan and emergency response plan function in a coordinated manner to prepare water service providers for the impacts of climate change. They also provide a viable approach to funding projects and plans, as well as to establish a process through which water districts in the Philippines can respond to and recover from a moderate emergency event with relative ease. This toolkit offers a clear path toward the transition of a water district to a "climate-ready" utility that is adaptive and prepared in the face of climate variability, extreme climate events and climate change impacts.

INTRODUCTION

Water utilities worldwide face increasing challenges related to the anticipated impacts of climate change. Important factors include:

- Increased variability in weather patterns and precipitation.
- Increased length and intensity of drought periods.
- Strengthening of tropical storm events.
- Increased storm surge.
- Increased surface water flows and associated erosion during rain events.
- Sea level rise and other associated impacts.

The toolkit includes lessons learned from the Philippine Community of Practice on Climate Change (CoP-CC) established by the Philippine Association of Water Districts (PAWD) from 2014 to 2015. The USAID Be Secure Project supported the capacity building of the CoP-CC through a twinning partnership with the Florida Climate and Water Alliance (FCWA) that was facilitated by WaterLinks, a non-governmental organization subcontracted by Be Secure. Six Philippine water districts participated in the twinning partnership: Leyte Metropolitan Water District (LMWD), Cagayan de Oro City Water District (COWD), Metro Iloilo Water District (MIWD), Isabela City Water District (ISAWAD), Zamboanga City Water District (ZCWD), and Metro Cotabato Water District (MCWD).

The analysis carried out by the six water districts during the development of the VAs identified the following to be the most common climate-related hazards experienced in the Philippines:

- Extreme rainfall conditions that lead to flooding and increase in turbidity
- Low-flow conditions arising from drought or extended dry periods, which affect water supply
- Increased surface temperatures that can lead to algal bloom affecting water quality and increasing evapotranspiration
- Typhoons and storm surges that may affect water infrastructure and other assets

With these impacts posing as real threats, water utilities should endeavor to become climate-ready, which will allow them to adapt and be prepared to deal with climate variability, extreme climate events and climate change impacts. To respond to these impacts, it is vital for water utilities to:

1. Assess the vulnerabilities existing within their systems.
2. Prioritize necessary projects to mitigate and adapt to climate change impacts.
3. Incorporate climate resilience into their traditional business planning frameworks.
4. Establish detailed emergency management plans to respond to emergency events efficiently and effectively.

This toolkit describes steps that a water utility can take to conduct a vulnerability assessment (VA); develop a climate-resilient business plan (BP) that integrates priority projects and actions

that were established by a VA into the normal course of water utility operations; and establish and implement an emergency response plan (ERP) that will allow a water utility to develop the precision necessary to efficiently and effectively respond to emergency events that may be exacerbated by climate change impacts. While it highlights case studies from Philippine water districts, the steps may be applied in general by any water utility that wants to increase its resilience to climate impacts.

This toolkit will guide water utilities in building a team to research and quantify regional climate trends and projections. The team should consider the threat level of climate change impacts on their infrastructure, watersheds and stakeholders, including determination of what assets are most likely to be damaged or lost to climate change impacts, and what level of risk tolerance is acceptable. The team should brainstorm possible solutions to the impacts and narrow options to a list of solutions that leadership, staff and stakeholders are willing to support within the realm of financial reality, consolidate actions and determine the best prioritization in which to protect the at-risk assets, and implement the plans and assess results.

Each of the recommendations provided works with and ties into other areas of water district planning and adaptation, such as water safety plans. With all three areas of climate readiness planning feeding into one another, water utilities are able to develop a reinforcing assessment and management model that will allow for the practical implementation of adaptation measures, while maintaining their ability to undertake everyday operations and maintenance, repair and refurbishment, and expansion of existing infrastructure. These will allow for continued growth and maturity within a water utility service area.

What does it mean to be resilient to climate change impacts?

Climate change impacts pose significant challenges to the ability of the water utility to provide safe potable water and to protect the watersheds and ecosystems upon which they depend for sustainable water supply. Extreme weather events, sea-level rise, temperature changes, and shifting precipitation and runoff patterns may result in changes to water quality and availability. In addition, climate change may affect local populations' ability to live and prosper, and could cause migration to other areas within a water utility service area. Uncertainty in climate change projections and difficulty in connecting these changes to local impacts pose a complex set of challenges to water utilities. Increased understanding of the existing vulnerabilities from climate change within a water utility and options for addressing them—in both day-to-day operations as well as emergency situations—have significant implications for the long-term resilience of a water utility.

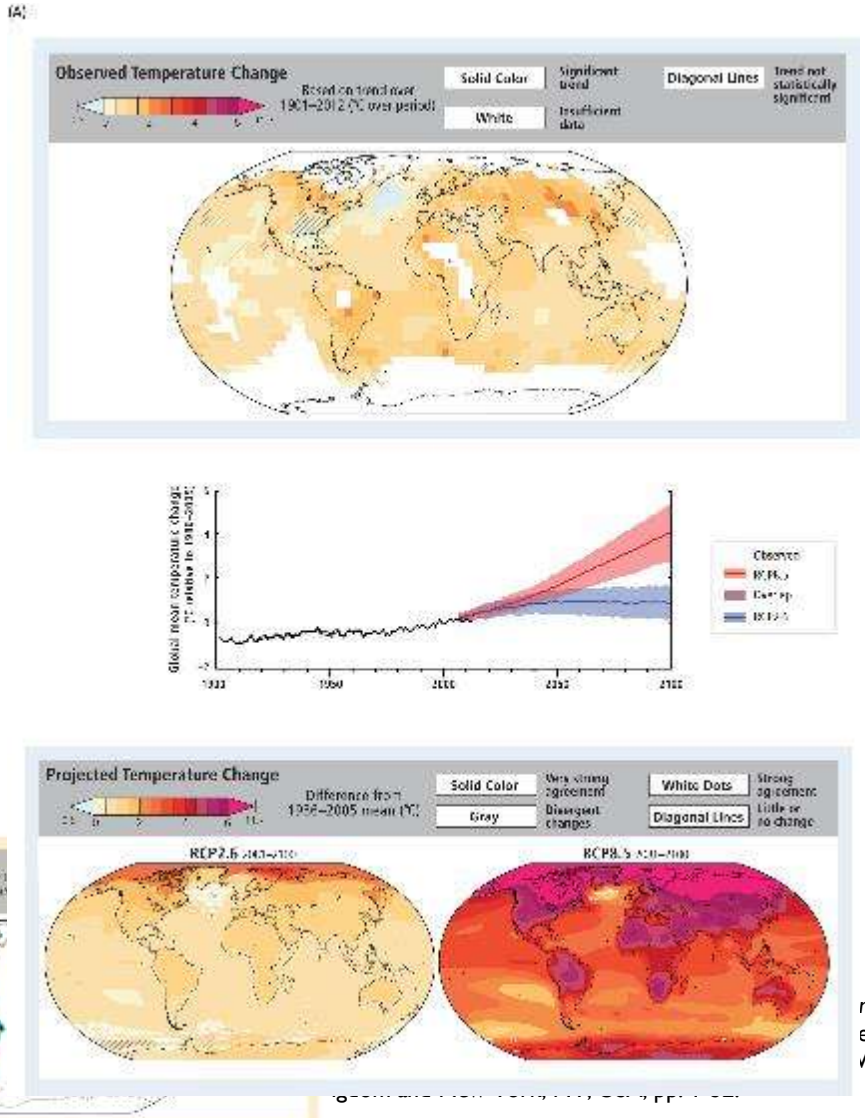
A water utility that is resilient to climate change impacts has:

1. Undertaken a thorough VA to determine areas of weakness that will be most impacted
2. Assimilated into its business plan those projects that have been determined to be priorities for ensuring its climate readiness
3. Undertaken the financial planning and adjustments necessary to implement the priority projects within the normal course of implementing the business plan and everyday operational and capital needs
4. Adopted an emergency plan ensuring that the water utility will be well suited to respond to the impact of emergency events likely to be caused or exacerbated by climate change

A BRIEF OVERVIEW OF CLIMATE CHANGE AND ANTICIPATED IMPACTS

> ***"…there is high confidence that impacts from recent climate-related extremes, such as heat waves, droughts, floods, cyclones, and wildfires, reveal significant vulnerability and exposure of many human systems to current climate variability"***
>
> ***– Intergovernmental Panel on Climate Change (IPCC)***

According to the Intergovernmental Panel on Climate Change (IPCC),[2] changes in climate patterns in recent decades have had an impact on natural and human systems on every continent and across the oceans. In many regions, changing precipitation or melting snow and ice are altering hydrological systems, affecting water resources in terms of quantity and quality. Based on many studies covering a wide range of regions and crops, negative impacts of climate change on crop yields have been more common than positive impacts.



Projected temperature[3] changes based on different emission scenarios are shown above and are based on the

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ıtribution of Working Groups I, II and III to the Fifth
ıate Change [Core Writing Team, R.K. Pachauri and L.A.

latest climate models. In general, the higher latitudes are expected to experience the greatest amount of temperature increase. This is problematic due to the impact on glacier melting of the polar regions. The impact is expected to increase sea level rise, leading to increased coastal flooding, storm surge and salt water intrusion. Temperature increases will also lead to increased water demand, water quality issues and supply shortfalls.

Precipitation[4] changes predicted by the IPCC range from increased wetter to dryer patterns. Increase in wetter seasons will lead to increased rainfall runoff, more intense rainfall events, and flooding. The length of the dry seasons is predicted to increase under many of the climate scenarios, with a general increase in the duration and severity of drought seasons. The Philippines has seen the results of the increased length of drought brought about by the influences of El Niño.

IMPORTANCE OF BEING PROACTIVE IN ADAPTATION PLANNING

Compared to reactive responses, proactive approaches to adaptation are more likely to lead to reduction or avoidance of damage. Anticipatory planning among water districts and other public and private entities will enhance resilience to the effects of climate change. It is estimated that every dollar spent on adaptation planning yields savings of up to five dollars in damages and reconstruction costs after major climate events.[5] All levels of government should consider the implications of climate change when making investments in long-lived infrastructure. These long-term investments will also benefit present stakeholders.

The strategic and integrated approaches described in this toolkit can reduce future risks and increase future benefits, and are considered examples of "good governance" towards a common goal. As future demands on limited water resources increase, local governments and water utilities will be the "front lines" where most of the planning and implementation must be carried out.

ASSEMBLING AN EFFECTIVE TEAM

It is vital to organize a team that will be able to collect and analyze the necessary information to develop and implement the assessment and plans themselves. Team members should include water utility managers, and operations and engineering staff. The development of the VA, BP and ERP requires input from every department within the organization. In addition, these staff will be responsible for cascading the plans down through the organization. Financial and communications personnel from the water utility are also vital to help identify and communicate financial constraints or limitations to the public and elected officials. The General Manager or designated Team Leader communicate emergency information and the plan with support from the communications personnel. If possible, also include representatives from meteorological, planning, and engineering academic institutions. It is important that the water district reach out to organization that can have a positive contribution on the content of the plans. It is

[4] Ibid.
[5] The Nairobi Work Programme on Impacts, Vulnerability and Adaptation to Climate Change. *Assessing the Costs and Benefits of Adaptation Options: An Overview of Approaches* (United Nations Framework Convention on Climate Change, 2011).

recommended to keep the group small (fewer than 10 persons).[6] Note that this is a general description of the team; roles and responsibilities will vary based on the water district's resources, and analysis and data needs.

The team leader should generally be a person with authority, such as a general manager or delegated assistant, who has the leadership ability to make educated decisions and hold members accountable. Developing the VA and other plans described in this toolkit can be a large undertaking; it is recommended that you start with a manageable document and build on it as time progresses. All the work products are living documents and need to be reviewed and updated on at least an annual basis as information and understanding about climate change increase and evolve.

The team should develop a timeline for accomplishing its tasks It took the six water districts described in this toolkit 15 months to produce the climate change VAs, climate-resilient BPs, and ERPs. Creation of the plans were beyond the day-to-day duties of the individuals tasked with this effort. The varying sizes of the six water districts also contributed to the level of complexity of the individual plans. Based on the experiences of the authors of this document, six months is needed to produce one of the plans contained within this toolkit. It is recommended that the team responsible for the plan(s) meet at least weekly to discuss progress, maintain momentum and generate enthusiasm. Full support of upper management and supervisors is critical to the success of the team and ultimately the plans. The team is ultimately accountable to their water districts, customers and other stakeholders.

In summary, the team should:

- Meet regularly;
- Get upper management support;
- Start with a manageable document; and
- Update plans yearly.

[6] WaterLinks Global Water Operators' Partnership Alliance (GWOPA). *A Tool for Coastal and Small Island State Water Utilities to Assess and Manage Climate Change Risk* (WaterLinks GWOPA and UN Habitat, 2016).

SECTION 1 – VULNERABILITY ASSESSMENT

A vulnerability assessment (VA) is the process of identifying, quantifying and prioritizing the weaknesses and vulnerabilities within a system. For water utilities dealing with climate change impacts, the VA involves the examination of existing above- and below-ground infrastructure, identification of areas of vulnerability, noting the likely climate impacts on the entirety of the system as a whole or in specified areas, and identification and prioritization of key projects necessary to upgrade the system or to mitigate or adapt to the climate change impacts. VAs focus both on the consequences of climate change for the water utilities, as well as on the primary and secondary consequences for the surrounding environment. It also concerns itself with the possibilities of reducing such consequences and of improving the capacity to manage future incidents.

The VA methodology in this toolkit is based on the bottom-up approach as described in *A Tool for Coastal and Small Island State Water Utilities to Assess and Manage Climate Change Risk*.[7] This approach offers an intuitive, evidence-based path to understanding climate change scenarios, impacts on operations, and options for adaptation. The use of a bottom-up approach is simpler, requires less data, and is more suited for developing countries where limited data and difficulty in accessing data hinder use of the more complex methodologies of a top-down approach. The starting point in developing a VA is the existing vulnerabilities of water utilities to one or more of the climate change impacts.

The development of a climate change VA is one of the more research-intensive aspects of climate-resilient planning and implementation. Although the scope and scale of the VA is determined by the needs and requirements of the individual water utility, there may be some limitation depending on data availability. Ideally, more information that is regionalized or localized to the geographic area in which the water utility is located will increase the accuracy and reliability of the assessment. Water utilities should also work with academic and governmental authorities, where possible, to access more data or identify areas of further research or data gaps to be filled that will allow for more intensive and accurate assessments in the future.

CLIMATE INFORMATION

How will climate change affect my region and what risks do those impacts pose to my infrastructure and stakeholders?

[7] Ibid.

The first step in undertaking a VA is to collect and review important climate information that is available and relevant to future impacts to the water utility. Downscaled climate projections should provide a localized snapshot of climate change variables over a minimum of 30 years into the future. The information developed during the initial data-gathering phase will provide the foundation on which the VA will be developed. The key question to ask is: *How will climate change affect my region and what risks do those impacts pose to my infrastructure and stakeholders?* Determining how much information is enough will ultimately depend on the information available, need to develop additional information scaled to the local level, cooperation with regional and national entities, and resources available.

VARIABLES TO CONSIDER

- Temperature
- Precipitation
- Sea level rise
- Extreme weather

How is this climate variable projected to change during the next 30 years (or more)?

Is it expected to increase or decrease?

As the VA is being developed, the team will need to collect available information about the specific ways that climate will impact the region or, if enough information is available, the local area where the water utility is located. Basic climate variables and questions to ask are listed in the side bar above. Try to collect information about how climate changes and their associated impacts might vary by season, to answer the question of whether the projected seasonal changes are larger or smaller than the variations that have been experienced previously. When possible, utilize as many sources of information as possible and carefully log the certainty of the information available. Try to understand and track why projections may vary from one study to another. From that database, a water utility can develop a table of anticipated impacts as an input to the vulnerability assessment.

It may be useful to develop a database of the following available information:

- The source of the information;
- The model used to develop a projection;
- Representative concentration pathways (RCPs)[8] (or other indicator) scenario used to guide the projection;
- The time frame of the future projection;
- Time frame of comparison; and
- The geographical area over which the projection was made.

[8] Richard Moss; Mustafa Babiker; Sander Brinkman; Eduardo Calvo; Tim Carter; Jae Edmonds; Ismail Elgizouli; Seita Emori; Lin Erda; Kathy Hibbard; Roger Jones; Mikiko Kainuma; Jessica Kelleher; Jean Francois Lamarque; Martin Manning; Ben Matthews; Jerry Meehl; Leo Meyer; John Mitchell; Nebojsa Nakicenovic; Brian O'Neill; Ramon Pichs; Keywan Riahi; Steven Rose; Paul Runci; Ron Stouffer; Detlef van Vuuren; John Weyant; Tom Wilbanks; Jean Pascal van Ypersele and Monika Zurek. 2008. *Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts, and Response Strategies* (PDF). Geneva: Intergovernmental Panel on Climate Change. p. 132

DEALING WITH SITUATIONS OF LIMITED DATA

We know more about how climate change affects certain areas of the world compared to other parts of the world. Depending on where the water utility is located, information regarding the variable impacts of climate change may be difficult to obtain, or information may not be sufficiently detailed for planning purposes.

One method in dealing with the lack of information is to **use projected climate data for similar geographical regions or climates**, noting that topographical differences may create microclimates that can significantly alter temperature or precipitation patterns.

Another method is to **use more general climate projections**. Experienced staff can predict how sensitive the area and infrastructure will be to future changes in climate and the associated impacts. Such an analysis will additionally provide direction regarding the most effective areas to gather additional data that will allow for more detailed projections in the future.

Although recommended actions within a VA may need to be limited to actions that could be considered "no regrets" in nature due to lack of detailed information, the identification of areas in which more detailed data could be secured will provide for more detailed and effective VAs in the future.

EXPOSURE TO CLIMATE HAZARDS

A changing climate will increase the stresses imposed on water utilities to supply water to its customers. Small changes in the timing and frequency of rainfall can change groundwater recharge patterns or filling/storage/discharge cycles of reservoirs. Higher temperatures can increase water demands and evapotranspiration.

In general, water utilities can expect the following impacts to facilities and operations:

CLIMATE STRESSOR	IMPACT AND RISKS
More frequent, intense rainfall events	• Increased sedimentation and turbidity. • Loss of reservoir storage capacity for water supply or flood control due to sedimentation accumulation. • Challenges to water treatment performance; increased turbidity will require additional chemicals or changes to treatment technology. • Direct storm and flood damage to water supply and water management facilities. • Landslides and washouts can impact water pipelines; intake structures can also be

CLIMATE STRESSOR	IMPACT AND RISKS
	impacted.

Sea level rise	• Increased saline intrusion and possible need for expensive treatment options:
	  ○ In groundwater aquifers, salt water intrusion may impact aquifers and wells.
	  ○ Brackish surface water sources may become saltier, requiring relocation or new treatment technologies.
	• Direct storm and flood damage to water supply water management facilities, flooding of facilities will require protection or even relocation

Warmer, drier seasons	• Vegetative changes in watersheds and recharge areas:
	  ○ Increased risks of wildfire; invasive species will impact rainfall runoff characteristics.
	  ○ Changes in quantity and quality of groundwater; recharge may decrease.
	• Increased water temperatures:
	  ○ Eutrophication and changes in aquatic species may impact surface water quality.
	  ○ Evaporation losses from surface waters and reservoirs may increase, resulting in less available water for domestic consumption or agriculture.
	• Increased water demand:
	  ○ Increased irrigation demands (longer growing seasons).
	  ○ Increased urban demands (dry spells, heat waves).
	  ○ Potential groundwater depletion and in-stream flow reductions.

The analysis carried out by the six water districts in the Philippines (LMWD, COWD, MIWD, ISAWAD, ZCWD, and MCWD) during the development of the VAs identified the following most common climate-related hazards:

- Extreme rainfall conditions that led to flooding and increase in turbidity.
- Low-flow conditions arising from drought or extended dry periods, which affect water supply.
- Increased surface temperatures that can lead to algal bloom affecting water quality and increasing evatranspiration.
- Typhoons and storm surges that may affect water infrastructure and other assets.

SENSITIVITY ANALYSIS[9]

Sensitivity is the degree to which a built, natural or human system is directly or indirectly affected by changes in climate conditions (e.g., temperature and precipitation) or specific climate change impacts (e.g., sea level rise, increased water temperature). If a system is likely to be affected because of projected climate change, it should be considered sensitive to climate change.

To determine the degree to which the water utility is sensitive to climate change, the following questions need to be addressed:

- What are the known climate conditions affecting the stresses on the water system? Be as specific as possible (e.g., list seasonal differences).
- How do these climate conditions affect the water systems that have been identified?
- What is the projected change in the climate conditions and by what time period?
- What is the projected climate change impact to the systems associated with this planning area?
- To what degree is the system sensitive to changes in climate?
- What are the projected changes in stresses on a system due to the projected climate change impacts? Are they likely to get worse, stay the same, or improve because of climate change impacts? Or, do new system stresses emerge altogether (i.e., water quality)?

What are the known climate conditions that will affect the stress on a given area of a water supply system? Evaluate above-ground infrastructure, below-ground infrastructure, water sources, and associated watersheds.

Tertiary factors could include impacts of climate change on social migration or demand management:

- Regulatory or legal constraints (i.e., restrictive procurement laws or limits on the expenditure of calamity/emergency funds)

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[9] A. K. Snover, L. Whitely Binder, J. Lopez, E. Willmott, J. Kay, D. Howell, and J. Simmonds. *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments* (in association with and published by Local Governments for Sustainability, Oakland, 2007).

- Political barriers
- Socio-cultural barriers (e.g., competing uses of a watershed, competing concessionaires, etc.)
- Challenges or restrictions to public–private partnerships (PPPs)
- Financial barriers
- Challenges in coordination (multiple agencies or stakeholders responsible for managing a system or watershed)
- Other physical, geographic or biological barriers (e.g., limits on water sources, location of existing infrastructure entirely within a flood plain)
- Rate of projected climate change likely to be faster than the adaptability of systems in the planning area

STEP-BY-STEP APPROACH TO CREATING A VA FOR WATER PROVIDERS

VAs should be undertaken in a way that incorporates the following steps, which are based verbatim on the document: *A Tool for Coastal and Small Island State Water Utilities to Assess and Manage Climate Change Risk.*[10] These steps were used in the development of the VAs by the six Philippine water districts mentioned in this toolkit and were found to be an easy-to-follow framework for the development of the VA.

STEPS FOR CREATING A VA

Step 1: Identify historical operational disruptions

Step 2: Assess historical rainfall and temperature variations

Step 3: Project rainfall and temperature changes

Step 4: Estimate climate change impacts

Step 5: Identify potential water supply shortfalls

Step 6: Evaluate adaptation options

Step 7: Develop a communications strategy

Step 8: Action planning, monitoring and evaluation as final implementation actions

STEP 1: IDENTIFY HISTORICAL OPERATIONAL DISRUPTIONS

Establish the exposure and sensitivity of water infrastructure assets by identifying and detailing all service disruptions over a 10- to 30-year period (or whatever maximum period for which data are available) that were caused by extreme weather-related events. List time periods (hours/days/weeks) for which services (intake, treatment, bulk supply, distribution, sewage disposal) were disrupted based on the following climatic events:

- Excessive precipitation
- Extreme dry weather or prolonged dry season
- High temperatures
- Typhoons and storms, including storm surge
- Flooding due to sea level rise

[10] WaterLinks Global Water Operators' Partnership Alliance (GWOPA). *A Tool for Coastal and Small Island State Water Utilities to Assess and Manage Climate Change Risk* (WaterLinks GWOPA and UN Habitat, 2016).

Estimate the financial impacts and record data such as direct cost impacts due to damage and indirect costs such as loss of revenue. Recording and noting financial losses caused by climate impacts will carry forward and will be used as part of the evaluation of adaptation options where avoided costs will be used in the analysis.

Identify and list the remedial short- or long-term measures that were implemented and indicate the costs. The costs could be either repetitive—such as having to replace equipment after each extreme storm event—or one-time costs, such as relocation.

CASE STUDY
LEYTE METROPOLITAN WATER DISTRICT (LMWD)

Population Served
The LMWD is a government-owned and -controlled corporation, which supplies potable water to Leyte's capital city, Tacloban City, in the Philippines, and seven municipalities. The water district has a total of 29,472 active service connections.

Description of Problem
On November 8, 2013, Super Typhoon Yolanda (international name Haiyan) hit Eastern Visayas, making landfall in Tacloban City. It was the most powerful typhoon in recorded history. Its impact on the water system included service line breakage, flooded/wind-damaged buildings and equipment, and landslides, which in turn impacted the water intake system of the treatment facilities. The following table lists some of the historical operational disruptions as documented by the LMWD.

LMWD Historical Operational Disruptions

Date	November 8, 2013	November 8, 2013
Extreme Event	Super Typhoon Yolanda (Haiyan)	Super Typhoon Yolanda (Haiyan)
Hazards of Each Event	Flooding	Winds
Description of Damage	Washout – embankment, silted and clogged intake structure	Damaged laboratory and admin building
Assets Damaged	Water intake facilities (2)	Damaged laboratory and admin building
Action Taken	Backfilling and de-silting work	Proposal for the reconstruction of laboratory
Upgrading/Retrofitting Placement Cost	200,000	9,000.000
Estimated Revenue Loss	1,964,516	None

STEP 2: ASSESS HISTORICAL RAINFALL AND TEMPERATURE VARIATIONS

Collect local precipitation and temperature data from the hydro-meteorological station(s) nearest to your source(s) of fresh water or treatment plant sites. Precipitation data may be available as hourly, daily, or monthly totals or averages. Each data set needs to have uniform sampling frequency. Collect at least 20 years of historical data and ensure that they are qualitatively accurate. Determine any trends.

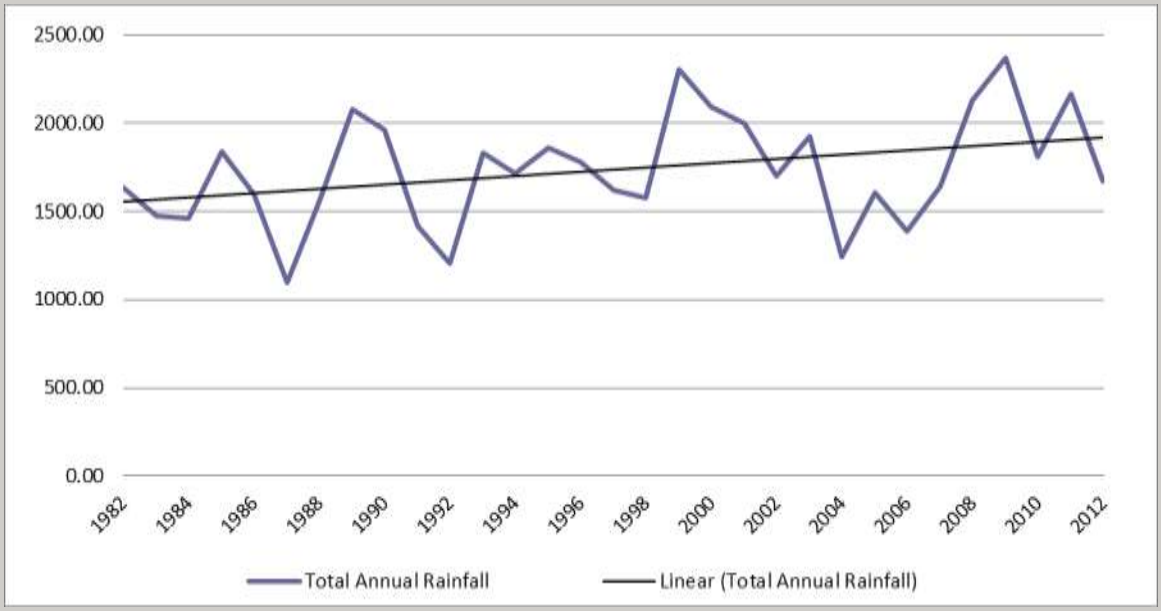
Tabulate and plot a line chart separately for precipitation and temperature showing annual averages for all data. Separately, tabulate and plot a line and/or bar chart depicting monthly averages within the time of historical data collected. Compare the dates and magnitude of the disruptions in service and related operational functions to the plotted historical data and identify any obvious correlations. Evaluate the results and attempt to establish patterns and probable causalities (e.g., if increasing dry periods are resulting in longer service interruptions). Include in the analysis any probable reasons for extreme deviations in patterns.

CASE STUDY
CAGAYAN DE ORO WATER DISTRICT (COWD)

Population Served
COWD is a government-owned and -controlled corporation created by Presidential Decree No. 198 or otherwise known as the Provincial Water Utilities Act of 1973. Generally, the service area of the COWD covers the entire city of Cagayan de Oro that comprises 80 barangays. The city was ranked the 10th most populous city in the Philippines in 2010. The topography of the city is characterized by a narrow plain along the Macajalar Bay and by the highlands separated by steep inclined escarpment in the south expanding from east to west. The terrain and topography of Cagayan de Oro allows seven rivers and six major creeks to drain to the Macajalar Bay. Presently, the district has water service to 64 barangays or 80 percent of the total 80 barangays within Cagayan de Oro and eight coastal barangays of Opol, serving a total population of approximately 560,000 residents.

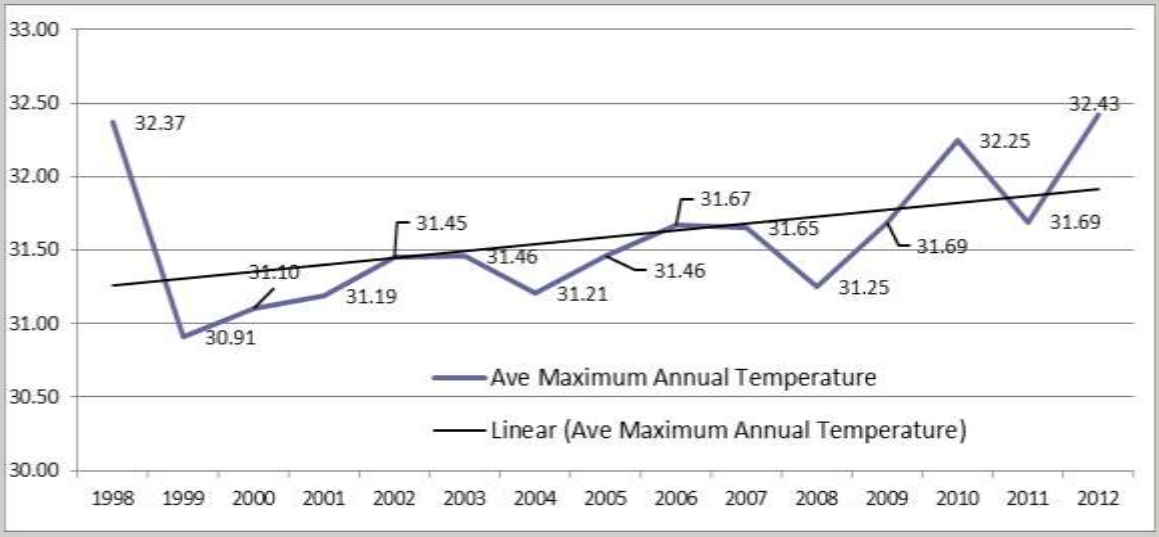
Description of Problem
A review of the precipitation records from 1982 reveals that annual precipitation averages about 1,700 millimeters of rain at a standard deviation of 314 millimeters. Fitting a line to determine the trend of this climate data demonstrates an increasing rainfall rate year after year. In the years 1997 and 1998 El Niño was present in the Philippines. However, as shown, the highest annual precipitation rate over the past two decades did not occur during the El Niño years.

COWD Annual Precipitation (1982-2012)



The temperatures in COWD have risen gradually over the past 17 years. Examining the temperature trend shows a decrease after the El Niño year of 1998 and an increase after about a decade.

COWD Annual Average Temperature (1998-2012)



STEP 3: PROJECT RAINFALL AND TEMPERATURE CHANGES

It is necessary to understand how future variations in rainfall and temperature will affect water availability, infrastructure assets and their operation, and ability to meet water demand. An effective VA requires the collection and review of projected climate information that is available and relevant to impacts to the water utility. The information developed during the initial data-gathering phase will provide the foundation on which your VA can be built. The key question to ask is: *How will climate change affect my region and what risk do those impacts pose to my infrastructure and stakeholders?* Determining how much information is enough will ultimately depend on the information available, the need to develop additional information scaled to the local level, cooperation with regional and national entities, and resources available. The climate information gathered should be at least consistent with global projections, plausible, applicable to the needs of the study, representative of the potential future range of variables and accessible.

CASE STUDY
ZAMBOANGA CITY WATER DISTRICT (ZCWD)

Population Served
The ZCWD currently serves approximately 55 out of the 98 barangays in the City of Zamboanga, Philippines, which contains 55,760 customers with an estimated population of 511,785. Water treatment facilities can produce a total of 108,554 m^3 of water per day. Water sources include groundwater, surface water, and developed spring sources. The average water demand (m^3/day) for the year 2014 is about 148,000 m^3/day, which is more than the daily production of all the treatment facilities combined.

The Manila Observatory (MO) prepared downscaled Global Climate Models of Zamboanga City that were presented during the USAID Forum on Understanding the Climate Change Projections for ZCWD and Planning for Urban Water Resilience held in 2015. Below are their projections:

Rainfall

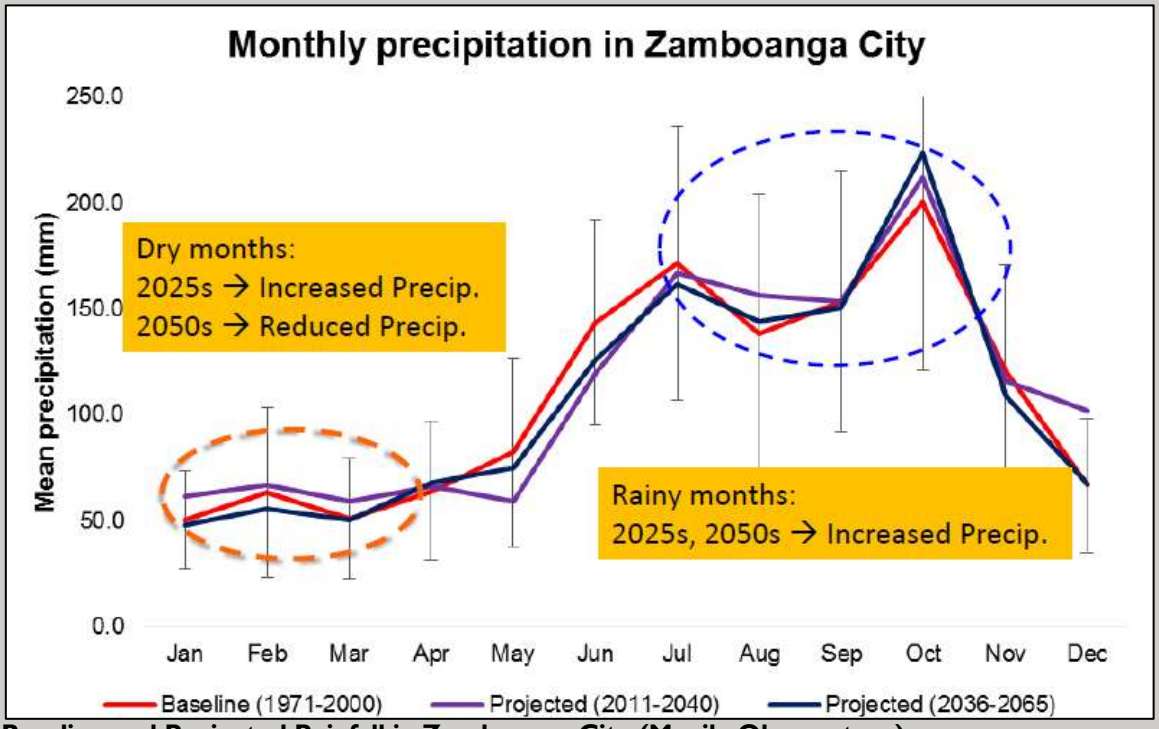
Dry months (January to April)

In 2025, there will be a slight increase in precipitation. However, this increase will be reduced by the year 2050. As shown in the figure below, the mean precipitation in 2050 will fall below the baseline most of the time.

Rainy months (July to October)

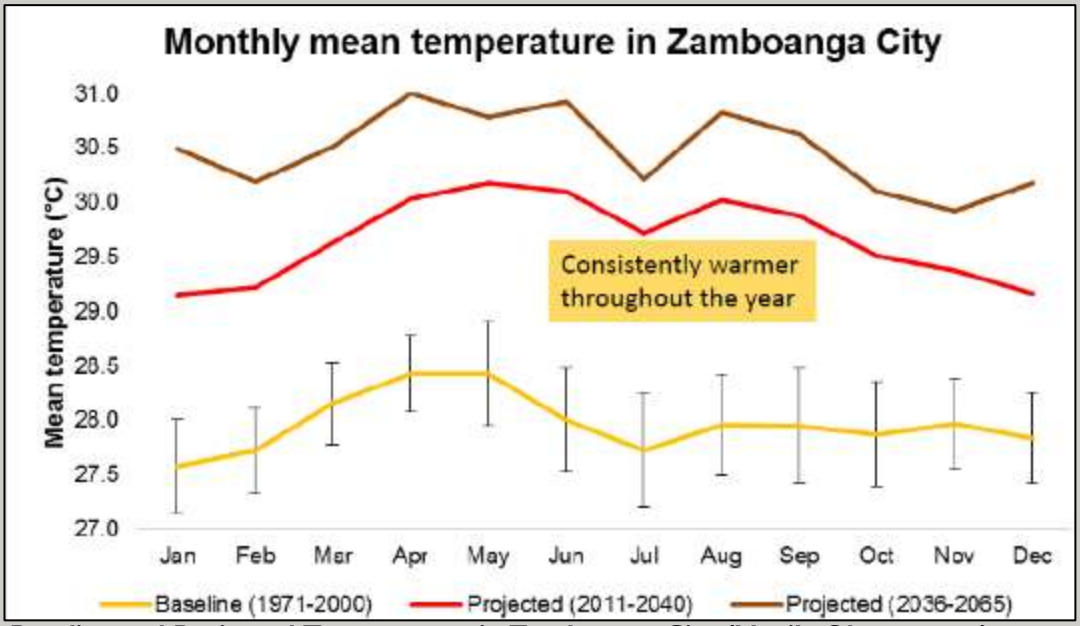
For the rainy months, especially in the month of October, there will be an increase in precipitation. Furthermore, it is important to note that in 2050, the mean precipitation will be below the baseline for most of the year except during the rainy months.

Overall, rainfall is projected to increase in the future. There will be an increase in the frequency of days with intense rainfall (140 mm/day, 160 mm/day and >200 mm/day).



Baseline and Projected Rainfall in Zamboanga City (Manila Observatory)

Temperature



Baseline and Projected Temperature in Zamboanga City (Manila Observatory)

Description of Problem
The figure above indicates that Zamboanga City will get warmer throughout the year, and more so in the relatively warmer summer months. The monthly mean temperature will increase by approximately 1.7°C from the baseline in 2011-2040 and will continue to increase to 2.5 °C in 2036-2065, with the mean daily temperature increasing by 0.9-2.2°C by 2025 and by 1.8-2.8°C by 2050.

The projected increase in future temperatures for Zamboanga City are consistent with other studies. Mean temperatures in all areas in the Philippines are expected to rise by 0.9°C to 1.1°C in 2020 and by 1.8°C to 2.2°C in 2050. The largest temperature increase is projected during the summer (March, April, May) season.[11]

Changes in Extreme Events
According to the Philippine Atmospheric Geophysical and Astronomical Services Association (PAGASA),[12] extreme weather events in Zamboanga such as hot temperatures (*indicated by the number of days with maximum temperature exceeding 35°C*) will continue to become more frequent. In 2050, there will be a total of 714 days with temperatures ≥35°C.

The number of dry days (*days with <2.5 mm of rain*) will decrease by the year 2020 to 7,058 days (2006 to 2035 centered at 2020) and will continue to decrease to 6,781 in 2050.

Heavy daily rainfall (*exceeding 300 mm*) events will continue to increase in number and will rise from 1 to 8 days by 2020 and increase slightly to 9 days by 2050.

Changes in Extreme Events[13]

No. of Days with Temperature >= 35 degree Celsius			No. of Dry Days			No. of Days with Rainfall > 300mm		
OBS (1971-2000)	2020	2050	OBS (1971-2000)	2020	2050	OBS (1971-2000)	2020	2050
54	114	714	8531	7058	6781	1	8	9

[11] Thelma A. Cinco, Flaviana D. Hilario, Rosalina G. de Guzman and Emma D. Ares, "Climate Trends and Projections in the Philippines" (paper presented at the 12th National Convention on Statistics, Mandaluyong City, Philippines, October 1–2, 2013; 4–5).
[12] Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), *Climate Change in the Philippines* (PAGASA, February 2011).
[13] Adapted from *Climate Change in the Philippines*, p. 40.

STEP 4: ESTIMATE CLIMATE CHANGE IMPACTS

To determine climate change impacts to surface water supplies, changes in precipitation and temperature (including extremes) will need to be compared to baseline or historical data. Risks arising from floods and droughts will also need to be determined.

Assessing Surface Water Supply
To determine the extent to which a surface water supply is affected by changes in precipitation, a correlation analysis between surface water level data and historical precipitation data needs to be carried out. If a statistical or obvious correlation exists between the two, use this correlation to determine the effects of future precipitation on water surface elevations. If there is no correlation, it can be concluded that there is sufficient water to meet demand regardless of changes in precipitation.

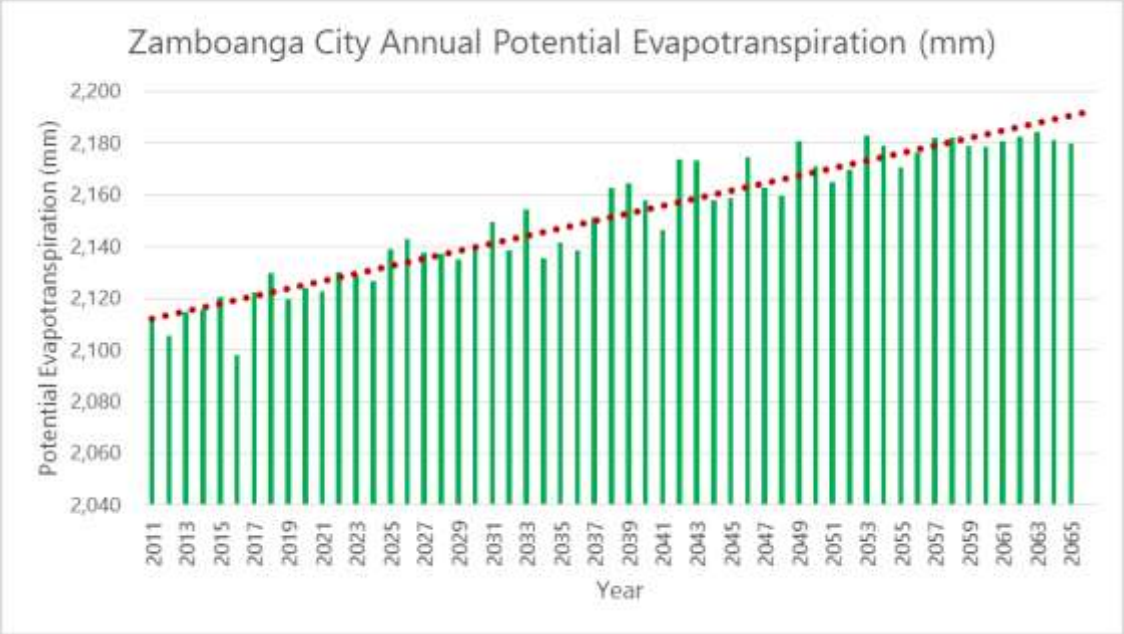
Surface water supply also requires determination of whether there are significant leaks or boundary inflows/outflows, and other factors that can affect the volume of water supplied to the water utility. These can diminish any direct correlation between the water supplied and precipitation. A multiple linear regression analysis can be used to establish relationships among the different variables.

CASE STUDY
ZAMBOANGA CITY WATER DISTRICT (ZCWD)

Description of Water Supply
The major source of domestic and industrial water in the ZCWD is the Tumaga River, which is within the Pasonanca Watershed. The watershed has a total land area of 12,032 hectares of old-growth forest and has the largest block of old-growth lowland dipterocarp forest remaining in this part of Mindanao. This watershed is the most significant source of potable water for Zamboanga and is a habitat for various threatened and restricted-range endemic species of flora and fauna. The ZCWD is the chief steward of the natural resource.

Description of Problem
The projected increase in the temperature and decrease in precipitation will increase the rate of evaporation of water into the atmosphere. Since the Tumaga River is the main source of water for ZCWD, the increase in evaporation and evapotranspiration (loss of water from soil and plant transpiration) will reduce the supply of water for domestic and agricultural use.

ZCWD Annual Potential Evapotranspiration (mm)[14]



It can be concluded that even though there will be an increase in rainfall, the increasing temperature will most likely also cause an increase in the water demand and a decrease in the water supply. Furthermore, the situation will worsen in 2050 when there will be a reduction in rainfall. Many important economic activities, such as raising livestock and growing food require water. The current rate of water demand for agricultural activities in Zamboanga City is about 8,000 m^3 per hectare. The city has an estimated 2,500 hectares of agricultural land. Therefore, the amount of water available for these activities may be reduced as the temperature increases and competition for water resources increases.

Assessing Flood Impacts

Using the Identifying Historical Operational Disruptions section as a guide, estimate the damage or disruption impacts on: (a) raw water intake areas; (b) treatment facilities; and (c) distribution systems, including water quality monitoring facilities, based on frequency and intensity of storm type and floodwater. Estimate costs of the disruptions, including: (a) asset repair, rehabilitation, or replacement; (b) disruption of services (loss of sales); (c) renewal of services; and (d) alternative service provision during period of disruption.

[14] Carlos Primo C. David, *Final Report for Preparing Vulnerability Assessments of Water Resources in Cagayan de Oro, Iloilo, Tacloban, and Zamboanga Cities* (2016).

CASE STUDY
LEYTE METROPOLITAN WATER DISTRICT (LMWD)

LMWD and its facilities, as well as its services, are vulnerable to hazards, i.e., flooding, storm surge, and typhoons as evidenced by the historical disruption in its operation. It is projected that facilities will face increased flood impacts in the future because of climate change.

LMWD Projected Flood Impacts

Hazards	Climate projections by 2050	Projected impacts on operations
Rainfall	Increase by 200 mm during monsoon periods	Inundation and siltation of Binahaan intake key facilities: ➢ Binahaan intake weir 1 and 2 ➢ Desander ➢ Settling tank Disruption of supply and treatment services: ➢ Water treatment plant no. 1 ➢ Water treatment plant no. 2 Inundation and total damage of key facilities in Dagami system: ➢ Improvised intake structure in Dagami ➢ Raw water transmission pipeline ➢ Improvised treatment plant shed ➢ Increase treatment expense

Assessing Drought Impacts

A water utility is concerned with two aspects of drought. The first is the physical effect on water quantity (supply) and water quality. The second is how the drought affects consumers (demand). A drinking water system will be affected by drought when decreasing supply intersects with increasing demand. Droughts expose vulnerabilities in the water supply, highlighting a need for water use planning and management. How a water utility responds to drought will depend on its size and watershed characteristics, and the relative contributions of precipitation, surface runoff, and groundwater to the overall water budget.

CASE STUDY

ZAMBOANGA CITY WATER DISTRICT (ZCWD)

Description of Problem

During drought or dry periods there will be a decrease in ZCWD water supply, specifically from the Tumaga River. Recently, the city experienced drought that caused water rationing to be implemented. Due to the water rationing, a loss in revenue was experienced. The drought had various impacts on revenues and cost of service. Less water usage reduced collections; lower water pressure caused by rationing also reduced water collections and led to operational difficulties and increased cost. The decreased inflow of water into the treatment facilities caused total water supply to the city to be reduced and water treatment plants were not operating at capacity while fixed cost remained constant.

The rationing scheme imposed due to the drought posed a threat to ZCWD's pipeline infrastructure. During water rationing, there are periods of time when pipes become empty due to full closure of valves, causing them to be filled with air, which make them susceptible to water hammer. Once the valves are reopened, the sudden acceleration of water results in the compression of the entrapped air, which increases the pressure inside the pipes and can cause failure. In addition, leakages aggravate the insufficient water supply and subsequently increase the rate of unaccounted water. At the same time, ZCWD incurred additional costs to repair pipes on top of the losses in sales due to decreased water supply. Based on the recent water rationing implemented in the city, there were 92 incidences of pipe failure, which cost approximately PhP 598,000 in repairs.

STEP 5: IDENTIFY POTENTIAL WATER SUPPLY SHORTFALLS

To identify overall water scarcity scenarios based on climate change factors, it is necessary to establish net water supply shortfalls, starting with forecasting water demand. The continuing rise in temperatures is a major factor in creating urban heat islands (UHI), and the projected increase in hotter and dryer periods usually leads to increased domestic consumption of water and electricity, higher industrial water demand, and increased evapotranspiration rates leading to lower groundwater recharge rates and lower water levels in reservoirs.

Several studies have confirmed the positive correlation between temperature and water consumption. However, the relationship is local and the specificity of the correlation is contingent on the months or seasons when the temperature changes occur. To determine the relationship between temperature and water consumption, a water utility–specific study is needed. There are many methodologies available and they will need to be adapted to the local area. If the water utility lacks the expertise, it is recommended that it collaborate with a local university or research agency and build on the existing literature. The study can include multiple linear regression analyses to determine the relationship between not only temperature change and household consumption, but also the relationship between extent of rainfall/dry days, cost of water, level of tourism, conservation strategies, sewer bill and other water-related tariffs, energy consumption, and other factors, depending on local socioeconomic conditions.

URBAN HEAT INDEX (UHI)

UHI is a phenomenon describing an urbanized area that is significantly warmer than its surrounding rural areas. This arises due to extensive modification of land surface to a less-permeable one, trapping the heat (short-wave radiation) in the city's surface. Note that ambient temperatures due to UHI is different from land surface temperatures. However, UHI is always higher than the latter.

It is important to keep in mind other factors that are sensitive to fluctuations in temperature (cooling and tourism-based activities, for instance). If a water utility is unable to carry out this type of study, it is recommended that it take a "no-regrets" approach. A water utility can utilize the established correlations found in previous studies and adopt these as indicative references for plans. For example, a 2007 study by Guhathakurta and Gober[15] on the influence of the UHI effect on water consumption in Arizona indicates that a 1°F ($^5/_9$°C) increase in low temperature results in a 290-gallon (1.1 m^3) increase in a typical single-family unit in a month. The water utility can increase or decrease the effect of temperature rise depending on the nature of typical households in the service area, and/or the presence of other major water consumers such as hotels. The decision on how to adjust this variable should also consider macro-scale factors outside the water utility service area and control. These could be increased allocation for power plant cooling, agriculture, or allocations made for other water utilities sharing the same water resources. By considering the projected temperature scenarios, you can integrate this correlation into future water demand projections. Water districts should collect as much customer data as possible not only for this analysis but for other studies such as tariff, capital planning, raw water supply, etc.

[15] Subhrajit Guhathakurta and Patricia Gober, "The Impact of the Phoenix Urban Heat Island on Residential Water Use," *Journal of the American Planning Association* 73, no. 3 (Summer 2007): 317–329.

CASE STUDY
ISABELA WATER DISTRICT (ISAWAD)

Population Served

The Sangguniang Bayan of Isabela by Resolution No. 1109 organized the Isabela Water District (ISAWAD) on June 4, 1987. It was later issued its Conditional Certificate of Conformance No. 330 on February 10, 1988. Its name was later changed to Isabela City Water District per ISAWAD Board Resolution No. 9, Series of 2001, after a plebiscite in 2001 that converted the then Municipality of Isabela to the City of Isabela. At present, the water district is providing the mainland population of about 79,793 with access to safe and potable water within the barangays covered.

The imminent impacts of climate change on water resources, particularly on quality and availability, is one of the major challenges that ISAWAD is working to address. The primary concern among these measures is not only building the supply capacity of the water district to meet the growing demands, but more importantly, building up its resilience in the event of extreme weather that may drastically affect its operations if not appropriately prepared for.

Description of Problem

Currently and under normal conditions, the water district's supply can provide for the water demand of its existing concessionaires. The table and graph below show the ten-year water production, consumption and non-revenue water (NRW).

ISAWAD Annual Water Production, Consumption, and NRW 2005-2014

Year	Production (in m3)	Consumption (in m^3)	% NRW
2005		1,350,725	21%
2006	2,747,520	1,525,554	44%
2007	3,265,920	1,699,168	48%
2008	3,265,920	1,784,585	
2009	3,265,920	1,867,620	43%
2010	3,265,920	1,957,531	40%
2011	2,989,903	2,185,438	27%
2012	4,074,270	2,407,530	41%
2013	4,117,988	2,532,679	38%
2014	4,010,090	2,584,980	36%

The average growth in service connections of the water districts for the past five years is 235 service connections per year. Currently, with the service connections at 9,380 as of December 2014, about 43 percent is being served or about 46,900 persons of the total population in the city.

Total Service Connections and Population Served
2010-2014

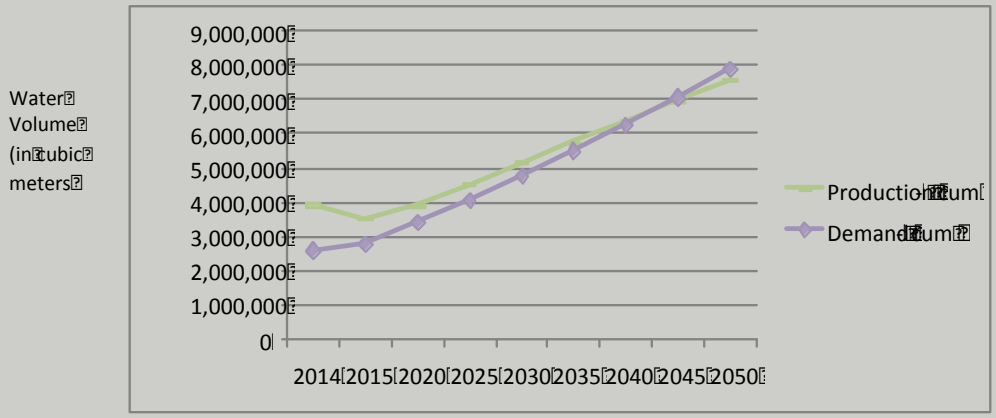
Year	Total Service Connections	Population Served*	Percentage of Total Population
2010	8,414	42,070	43%
2011	8,898	44,490	44%
2012	9,249	46,245	45%
2013	9,037	45,185	42%
2014	9,380	46,900	43%

*Computed at 5 persons per service connection

With the excess water supply production and measures to significantly reduce NRW to 20%, the water district is projecting about 800,000 m^3 of water available to supply about an additional 2,400 households in the city based the present average monthly consumption of 27 m^3 per household.

In consideration of the capacities of present water sources, the increase in population, and the growing demand for water supply, the graph below shows the projected supply and demand between years 2020 and 2050.

ISAWAD Projected Water Supply and Demand
2015-2050



The graph above depicts the narrowing margin between supply and demand in 2020 and the likelihood of supply shortfall beginning in the year 2035. The projected scenario above does not yet consider impacts of climatic conditions and non-climatic factors that would affect the viability of the present water supply resources of the water district.

STEP 6: EVALUATE ADAPTATION OPTIONS

The next step in the development of a VA is identifying adaptation options that reduce system vulnerabilities. In addition to reducing risk, adaptation options should also be considered with respect to current water district improvement plans and priorities, and current and projected available resources. In general, adaptation options can be categorized as either ***operational*** or ***capital***. Operational options improve efficiency and include factors related to monitoring, inspection, conservation, demand management, and flexible operations. Capital options are related to construction, water resource diversification, repairs and retrofits, upgrades, new technology, and green infrastructure.

An important concept in evaluating adaptation options is "no regrets" options, which benefit operations at water utilities if implemented, regardless of projected changes in climate and extreme weather. Therefore, no regrets options build resilience to the potential impacts of climate change while yielding other more immediate economic, environmental or social benefits. It is important to note that no regrets options are not cost-free options. No regrets options still have real or opportunity costs or represent trade-offs that should be considered.

Example of no regrets options include:

- Improved water use efficiency by customers;
- Reducing NRW loss; and
- No water facilities located in high-risk areas.

Operational options improve efficiency and include factors related to monitoring, inspection, conservation, demand management, and flexible operations.

Capital options are related to construction, water resource diversification, repairs and retrofits, upgrades, new technology, and green infrastructure.

No regrets options benefit operations at water utilities if implemented, *regardless of projected changes in climate and extreme weather*.

Operational Adaptation Options

Two of the most important operational adaptation options that can be carried out by water utilities are also no regrets options. The reduction of NRW and reduction of water demands are operational programs that are vitally important to building a resilient water utility, reducing overall tariffs, and allowing growth while minimizing impact to existing supplies. Therefore, all water utilities should strive to implement these options regardless of projected climatic impacts

a) Reduce NRW

The process of identifying the range and scale of the NRW problem as well as its solution is variable and may take several years, depending on available investment resources and the magnitude or rate of NRW reduction required. Public water systems in the Philippines commonly have NRW rates of approximately 50 percent, which means half the water supplied is either lost through leaks and pilferage or under-estimated through inaccurate water meters. Ideally, NRW goals should be set at about 20 percent in order to maximize investment and increase efficiency. It is more cost-effective to increase or recover water resources by reducing

NRW than it is to identify new sources, develop them, and build the infrastructure to access, treat and distribute the additional water.

Typically, water utilities should be able to recover 50 percent or more of the NRW. In most cases, this would be sufficient to meet shortfalls in supply, although the lowest possible figure of resultant NRW should be the goal. Extreme situations where rates of increase in demand are high, coupled with a steep decline in raw water availability due to climate change–related factors, will require a higher rate of reduction in NRW over a shorter (or longer) period as needs dictate.

Simple Steps for Reducing NRW:

1. Undertake a comprehensive audit of the utility's water loss, including:
    a. Volume, rate, and locations of loss;
    b. Principal causes of loss (e.g., network leakages, inaccurate meters, unbilled consumption, theft);
    c. Deficient operating systems and processes, and remedies. Remedies can include: pipe replacements; repairs; creating district metering areas to manage water supply in discrete hydraulic operable areas; adopting technology-based solutions for leak detection, repair, and control; and creating an active leakage management system with trained staff and integrated technology. Unless sufficient in-house expertise is available, outside expert assistance may need to be sought.

2. Identify and evaluate options:
    a. Develop a range of options with volume of water saved at different levels of NRW reduction, e.g., 50 million liters per day (MLD) at 40 percent NRW, 100 MLD at 20 percent NRW, and 125 MLD at 10 percent NRW.
    b. Estimate costs and time frames associated with each option.
    c. Correlate the savings with the estimated shortfalls in supply over points of time and judge optimal scenarios. Note that 80 percent of NRW in most utilities is physical loss; concentrating on reducing this loss creates new water. The remaining 20 percent are typically commercial losses; reducing them often enables you to secure sufficient revenues to finance the entire NRW reduction program.

3. Evaluate results: If reducing NRW creates sufficient additional water to meet estimated shortfall, then the water utility can proceed without seeking additional water sources. However, recovering this water is not an infinitely elastic exercise and, at some point (typically sooner than later), demand should stabilize and be based on:
    a. Efficient consumption; and
    b. The economic price of water. It will be in the water utility's interest to promote efficient consumption of water given the long-term negative climate change impact scenarios.

b) Reduce Demand

Efforts to reduce water demand are typically implemented when there is wasteful consumption, there is insufficient raw water to meet current needs, and/or when long-term supply and demand scenarios are deficient. For instance, several utilities have design parameters that include daily per capita consumption between 180 and 400 liters per person. In most cases,

these parameters are rarely met mainly because of a shortage of water coupled with high rates of NRW. Urban water demand has two principal elements: domestic and industrial. These are addressed below.

Reducing water demand should be considered a primary water utility's goal due to the uncertainties of long-term raw water availability.

Calculating the impact of reduced water demands
To calculate the desired reduction in water demand based on demand and supply projections over 5-year intervals, use these steps.

Inflate the net demand with an assumed worst-case scenario factor; for example, 15 percent for each 5-year segment (to account for unforeseen growth). Calculate daily demand identified for reduction and include a 20 percent supply safety factor. This safety factor assumes a reduced NRW figure. See sample calculations provided below as illustrative examples:

SAMPLE CALCULATIONS

A.	Projected Total Daily Demand: Projected Total Daily Supply:	100 MLD 100 MLD
B.	Increase Demand by 15%:	115 MLD
C.	20% Safety Factor:	80% of 100 MLD = 80 MLD
D.	Demand to be reduced:	115-80=35 MLD

Based on available consumption data, calculate the extent to which demand can be reduced in the domestic and industrial sectors separately. A proportionate reduction can be developed, i.e., a reduction in proportion to the relative consumption by the two principal consumers. Alternatively, a reduction in domestic demand can be developed by creating a new level of service; for example, 160 liters per capita per day (lpcd) versus a current level of service that may be 230 lpcd. For industrial consumers, a flat rate reduction (e.g., 10 percent) may be developed. It may be more difficult to reduce industrial demand because of the time lag to develop more water-efficient industrial processes.

NOTE: The Zamboanga City Water District, with assistance from Be Secure, developed a water audit toolkit that includes practical steps for reducing demand through water efficiency and conservation measures.

EXAMPLES OF DEMAND REDUCTION MEASURES

Demand reduction programs can be developed that incorporate a blend of the following elements:

Price Mechanism. This is a complex analysis and difficult to develop. To use this methodology, the water utility develops a formula that goes beyond recovery of costs of supply and includes a "climate change insurance premium." This is a proxy for the scarcity value of water (or its economic value), and helps in moderating demand. As a particular user has an increase in consumption, a penalty in the form of higher rate is imposed, which is also described as an inverted rate structure. Expert advice is needed to develop an inverted rate structure that is both credible with consumers and has the clear potential to reduce demand.

Water Reduction/Savings Fittings. Design or modify codes to require domestic consumers to move to technologies such as efficient shower heads, low-flush toilets, front loading washing machines and efficient garden irrigation systems.

Rainwater Harvesting. Require all potential new commercial, residential and government buildings to incorporate rainwater harvesting infrastructure. In addition, retrofitting of existing facilities wherever feasible is also advisable. Seek expert assistance to implement an effective program for local governments.

Reducing Industrial Consumption. Implement a program to induce reduced water consumption by industrial, business and energy companies through measures such as reduced water losses, efficient water use processes, and codes that require treatment and reuse of wastewater.

Capital or Engineering Adaptation Options

Capital adaptation options—also known as engineering options—are an essential part of the process of adaptation, both ensuring that current infrastructure assets are protected from the short- and long-term effects of climate change, and developing new infrastructure systems that can adapt to changing climate conditions. Investing in capital adaptation options that protect infrastructure is essential for minimizing the risks to infrastructure and thereby the water utility.

An important concept to note during the planning and implementation of capital adaptation options is that of **maladaptation,** which is a project or policy that creates or exacerbates a problem. For example, in Honduras, a levee was built to protect pre-existing homes located in a floodplain from river flooding. However, the construction of the levee created incentives for people to relocate or build their homes immediately inside the levee, thereby increasing the number of people exposed to flood risks. Another example is in the United States where the government subsidizes flood insurance premiums, a measure that encourages development in areas prone to flooding, such as the low-lying barrier islands along the east coast of Florida.

A Vulnerability Assessment Spreadsheet (VA Spreadsheet) can be used to facilitate the planning of capital projects that deal with climate change. The VA Spreadsheet prioritizes capital adaptation options based on risk, cost, and avoided climate-related infrastructure damages, all of which provide a basis for complete decision making and a technically sound and defensible matrix of

climate adaption options. The results of the analysis used in the VA spreadsheet can be used to seek funding, and gives a level of confidence that the options have been vetted in a quantitative and defensible methodology.

VA Spreadsheet

The VA spreadsheet contains several terms that are important to understand before carrying out an analysis:

DEFINITIONS

- *Threat* – climate or extreme weather threat such as flooding, wind, drought, etc.
- *Structure* – infrastructure that can be damaged by extreme weather events, e.g., intake structures, building, pipelines, etc.
- *Subsystem* – smaller or clearly defined portions of the infrastructure, e.g., electrical building, tank, intake pipe, pumps, etc.
- *Probability* – chance or likelihood of threat occurring, based on low, medium, or high criteria
- *Consequence* – what will happen? disruptions, damage, loss, etc., based on low, medium, or high disruption criteria
- *Adaptation option* – what can be done to reduce or eliminate damage from the threat?
- *Adaptation score* – a numbering system developed by the user to rank options
- *Non-climate factors* – factors that may affect the ability of the water utility to carry out adaptation options; can also mean factors that further exacerbate climate change impacts

The latest version of the VA Spreadsheet is available at:

https://www.dropbox.com/sh/syzei2bs1ybe09z/AAAzlHQhv7lW6gjpW6ybcPw7a?dl=0

Water System Vulnerability Assessment

Completed by:

Date:

Facility:

System	Subsystem	(b) Threat	(c) Probability of threat occurring	(d) consequence should the threat occur	(e) Risk (c) x (d)	(f) Probability of threat occurring	(g) consequence	(h) Risk (f) x (g) x 0.5	(i) Probability of threat occurring	(j) consequence	(k) Risk (i) x (j) x 0.25	Vulnerability Score (l) (e)+(h)+(k)	Adaptation Improvements	Adaptation Cost	Avoided Cost	Adaptation Score	Non Climate Factors (subjective to be used for similar adaptation scores)					Assumptions in risk rating/notes
																	Non-Revenue Water	Institutional & Legal	Political Issues (Interfe	Unregulated and	Encroachment into watershed and distruction of	

Elements of the VA Spreadsheet

Infrastructure system and threat:

(a) System	Subsystem	(b) Threat

Present and future risk analysis section:

(c) Probability of threat occurring	(d) consequence should the threat occur	(e) Risk (c) x (d)	(f) Probability of threat occurring	(g) consequence	(h) Risk (f) x (g) x 0.5	(i) Probability of threat occurring	(j) consequence	(k) Risk (i) x (j) x 0.25	Vulnerability Score (l) (e)+(h)+(k)
Present			**Future 2050**			**Future 2100**			

Probability of threat occurring, likelihood that the threat will occur:

1 – Low
2 – Medium
3 – High

Consequence should the threat occur, based on water utility's ability to deliver safe water:

1 – Low (minimal disruption)
2 – Medium (some disruption, less than 24 hours)
3 – High (disruption longer than 24 hours)

Both the probability and consequence numerical values are arbitrary and any range of values can be used, e.g., 1-5, but the lowest value needs to be a numerical value of 1.

Risk, which is simply the probability multiplied by the consequence. The lower the value the lower the risk. The values in red (0.5 and 0.25) are values representing present risk as more important than future risks. The VA Spreadsheet is based on present risks being of greater importance than future risks due to their more certain nature.

Present, Future 2050, and Future 2100 are the three periods for which risk is being evaluated. Any future time period can be used, e.g., 2040, 2050, etc.

Vulnerability Score is the dimensionless sum of the three risk periods: present, 2050 and 2100. The higher the vulnerability score, the more exposed the system and subsystems are to damage from weather events.

Proposed Adaptation Options Section:

Adaptation Improvements	Adaptation Cost	Avoided Cost

Adaptation Improvements are proposed adaptation improvements, e.g., building hardening, riverbank hardening, relocation of facilities, etc.

Adaptation Cost represents the capital cost of the adaptation option at the present value.

Avoided Cost is the cost of the damage that *will not occur* due the implementation of the adaptation option. This is an important concept of the VA Spreadsheet analysis. The avoided cost is used to reduce the capital cost and is critical to the proper ranking of options. The avoided cost can be repetitive costs, for example, relocating pump equipment from a flood-prone area may avoid equipment repair or replacement cost every x years based on the recurrence of a flood.

Score Section:

Adaptation Score

Adaptation Score is a dimensionless number that is based on the following formula:

(avoided cost-adaptation cost)/adaptation score x (user-defined factor)

The user-defined factor allows the adaptation score to become a more understandable number. For example, if the adaptation score is .0123, multiply by 1,000 to obtain an adaption score of 12.3, which is easier to use during comparison.

CASE STUDY
ISABELA WATER DISTRICT (ISAWAD)

From the ISAWAD VA spreadsheet, the vulnerabilities of the different facilities have been ranked and listed in the tables on the next two pages according to their levels of vulnerability.

ISAWAD VULNERABILITY RANKING OF THE DIFFERENT SYSTEMS AND SUBSYSTEMS

(ARRANGED FROM HIGHEST TO LOWEST VULNERABILITY SCORES)

SYSTEM	SUBSYSTEM	VULNERABILITY
Intake Facilities	Coffer Dam 1 – Kapatagan Grande Source	Heavy Rainfall (structural damage due to river bank erosion)
Intake Facilities	Coffer Dam 1 and 2 – Bucol Source	Heavy Rainfall (structural damage due to flooding as well as clogging of intake
Water Treatment Plant	Sedimentation and Filtration Tanks – Balanban	Heavy Rainfall and Gusty Winds (structural damage due to erosion or landslide and uprooting of trees)
Transmission Pipeline	Pipelines – Kapatagan Grande Source	Heavy Rainfall (pipeline breakdown and water loss due to flooding as well as increased turbidity due to intrusion of sand/silt)
Transmission Pipeline	Pipelines – Bucol Source	Heavy Rainfall (pipeline breakdown and water loss due to flooding or landslide as well as increased turbidity due to intrusion of sand/silt)
Transmission Pipeline	Pipeline – Small Kapatagan Source	Heavy Rainfall (pipeline breakdown and water loss due to flooding or landslide)
Storage and Distribution System	Reinforced Concrete Ground Reservoir – Balanban	Heavy Rainfall and Gusty Winds (structural damage due to erosion or landslide)
Storage and Distribution System	Distribution Pipelines and Lateral Lines	Heavy Rainfall (pipeline breakdown on old and dilapidated pipes due to high pressure)
Intake Facilities, Pipelines, Storage and Distribution System	New System	Dry Spell/Drought (reduced water supply)
Intake Facilities	Menzi Source and Panunsulan Source	Dry Spell/Drought (reduced water supply)
Watershed	Vegetative Cover	Gusty Wind (uprooting of trees and other vegetation)
Water Treatment Plant – Balanban	Sedimentation and Filtration Tanks – Balanban	Heavy Rainfall (increased turbidity of raw water)
Water Treatment Plant	Sedimentation and Filtration Tanks - Menzi	Heavy Rainfall (increased turbidity of raw water)
Storage and Distribution System	All Reinforced Concrete Ground Reservoirs	Gusty Winds (structural damage due to falling trees)
Water Treatment Plant	Sedimentation and Filtration Tanks – Menzi	Heavy Rainfall and Gusty Winds (structural damage due to falling rubber trees)
Intake Facilities	Settling Tank – Kapatagan Grande and Bucol Sources	Heavy Rainfall (structural damage due to flooding as well as accumulation of sand/silt)

ISAWAD VA Spreadsheet

System	Subsystem	(b) Threat	(c) Probability of Threat Occurring	(d) Consequence Should the Threat Occur	(e) Risk (c) x (d)	(f) Probability of Threat Occurring	(g) Consequence	(h) Risk (f) x (g) x 0.5	(i) Probability of threat occurring	(j) consequence	(k) Risk (i) x (j) x 0.25	Vulnerability Score (l) (e)+(i)+(j)	Adaptation Improvements	Adaptation Costs (m)	Avoided Costs (n)	Adaptation Score [(n/l) - (m/l)]*0.001	
			Present			Future by the 2050			Future by the 2100								
EXTREME RAINFALL CONDITION																	
Watershed	Vegetative Cover	Gusty Wind (uprooting of trees and other vegetation)	1	3	**3.00**	2	3	**3.00**	3	3	**2.25**	9	Replanting of trees and other indigenous vegetation	**₱ 600,000.00**	**₱ 741,725.00**	16	
Intake Facilities	Coffer Dam 1 Kapatagan Grande Source	Heavy Rainfall (structural damage due to river bank erosion)	2	3	**6.00**	3	3	**4.50**	3	3	**2.25**	12	Construction of river bank protection at critical embankment	**₱ 1,500,000.00**	**₱ 1,809,049.42**	26	
Intake Facilities	Coffer Dam 1 and 2 – Bucol Source	Heavy Rainfall (structural damage due to flooding as well as clogging of intake)	2	3	**6.00**	3	3	**4.50**	3	3	**2.25**	12.00	Construction of barriers before the dam to trap logs and other large objects	**₱ 500,000.00**	**₱ 1,223,887.82**	60	
Intake Facilities	Settling Tank – Kapatagan Grande and Bucol Sources	Heavy Rainfall (structural damage due to flooding accumulation of sand/silt)	1	2	**2.00**	2	2	**2.00**	2	2	**1.00**	6.00	Installation of sand/silt barrier in the settling tank	**₱ 500,000.00**	**₱ 1,738,852.87**	206	

STEP 7: DEVELOP A COMMUNICATIONS STRATEGY

The impacts of climate change on a community's water demand and supply arrangements are sufficiently serious for your water utility to design and implement a communications strategy. A good strategy should (a) educate the community about the major impacts; (b) describe the proposed means of addressing them; and (c) include community members as active participants in the process.

The major stakeholder groups include: domestic consumers—especially those segments of the urban population who either have no or limited access to piped water supplies; commercial and industrial consumers; local government officials; elected representatives of communities; nongovernmental organizations (NGOs) involved in water and sanitation services; and the media.

A communications strategy should typically explain the following in simple and clear terms:

- Objectives of the overall impact assessment and remediation exercise with the stakeholder community
- Approaches and methodology used
- Sequence and timing of constituent elements
- Results of option studies with costs and benefits transparently demonstrated
- The manner of engagement of key stakeholders with the progress of the program and their participation in it

It will be helpful to establish mechanisms to report progress to the wider water community and to seek feedback on the process. *The involvement of stakeholder groups is key to the success of the remediation exercise.* This part of the strategy will require careful design, perhaps with expert assistance.

STEP 8: ACTION PLANNING, MONITORING AND EVALUATION

Assemble a comprehensive least-cost techno-economic program of action to deal with climate change impacts based on the steps in this Vulnerability Assessment Section. Integrate the program with the water utility's capital and operating budgets. Review monitoring and evaluation arrangements and strengthen as required to provide real-time reports on implementation and results.

Periodically report to customers, local government officials, partner agencies (e.g., electric power supply company, storm water management, town, and country planning authority, etc.) and share the program components and details together with reasoning and costs. Build consensus and acceptance for the program in a with-program and without-program scenario.

SECTION 2 – CLIMATE-RESILIENT BUSINESS PLANNING FOR UTILITIES

WHAT IS A CLIMATE-RESILIENT BP?

Business planning is a targeted extension of the strategic planning process that seeks to make decisions and formulate actions that will fulfill the vision of the strategic plan. The business planning process requires the development of quantified strategic objectives that are supported by clearly detailed performance indicators to measure the success of the plan. Integrating climate resilience into a traditional BP requires a balance between traditional capital, financial and operational needs, as well as the incorporation of climate resilience as prioritized and articulated in the VA. The business plan should be short-term in nature, covering from about three to five years. When incorporating the results of the VA into the business planning framework, water utilities must address:

- What is going to happen? For example, will sea levels rise and impact groundwater supplies? Will precipitation increase, impacting runoff and the level of flows and turbidity of water supplies?
- When is it going to happen? Within what time frame does a water utility anticipate the impacts occurring?
- How much will it cost? What is the cost of undertaking projects to address the climate impacts?

Some climate risks are greater than others. Some risks with less disastrous consequences may be considered manageable by a utility or community, provided affordable measures can be put in place to address them if they occur. Climate-resilient business planning will help to determine an acceptable level of risk due to climate change impacts, reduce uncertainty, improve efficiency, provide a clear narrative for stakeholders, and allow for a basis to monitor and measure progress. Implementation of adaptive management through annual assessment and measures of success allows for continued growth and flexibility, as well as the ability to adjust if climate impacts are greater or lesser than anticipated.

WHY HAVE A CLIMATE-RESILIENT BP?

The development of a BP that incorporates climate resilience allows for a water utility to integrate necessary projects into existing programs and approaches, in order to mitigate and adapt to the impacts of climate change. This will contribute to the achievement of strategic goals (performance improvement planning) as well as adaptive management of the programs over time.[16] Climate-resilient projects and approaches that have been identified and prioritized should include:

- Water sources
- Transmission structures
- Treatment systems
- Storage facilities
- Allocation mechanisms
- Reuse/disposal processes
- Wastewater systems

[16] This section is meant to serve as a supplement to other guides developed by the USAID, such as "Strategic Business Planning for Water Districts: A Guide and Model for the Preparation of Business Plans for Water Districts" (December 2009). Its focus is on incorporating climate resilience and outcomes of a VA into an existing BP.

- Disaster preparedness plans
- Emergency response systems
- Financial management

THE IMPORTANCE OF EFFECTIVE COMMUNICATIONS

The climate-resilient BP gives a water utility the ability to provide the public, its stakeholders, other governments and agencies, and its board of directors a document that articulates the history and development of the water utility, details regarding the "how" and "why" of service delivery, and a clear road map to demonstrate the realization of high-quality service, even in the face of climate change impacts. In developing the BP, water utilities should ensure that it is clear, reader-friendly, and can be utilized by public relations staff in outreach efforts that generate further support for the water utility. The document should develop and explain the levels of funding and rate structures necessary to undertake projects prioritized by the VA, and justify these projects within the scope of normal water utility operations and responsibilities. Most importantly, it is an opportunity for water utilities to lay out the climate-related challenges facing their locality and region, and the solutions being developed to mitigate and adapt to these challenges!

ASSEMBLING AN APPROPRIATE TEAM

Although an overarching management group is needed to tie the VA, BP and ERP together, the three components will require expertise from a variety of technical, scientific and fiscal experts. Water utilities may want to consider forming sub-teams to provide input on specific areas of expertise (i.e., fiscal analysis, climate science, emergency needs, and inventory) or can choose to rotate experts into the larger management group when needed. Regardless of what framework is chosen, the process should be well established and transparent to both the participants and associated stakeholders. Participants in the development of the climate-resilient BP should include:

- Water utilities management staff
- Stakeholder groups
- Customer representatives
- Government officials/representatives
- External advisors

In developing the climate-resilient BP, customers, stakeholders, staff and management can provide valuable feedback regarding implementation of the business plan, future vision, and areas of weakness. For those members who are not regular participants in management meetings or are external stakeholders, surveys are effective tools of measurement and can be accomplished efficiently online.

The team should meet a minimum of once a month and should establish sub-teams as necessary to incorporate technical and financial experts to provide additional detail and input. Finalization of the document will depend on the maturity of the existing business plan. If starting from nothing with little established information, development of a climate-resilient BP may take up to 18 months. If working from an established business plan, the incorporation of climate resilience should be able to be accomplished within a six-month period. The climate-resilient BP should be assessed and updated at least once a year to measure progress towards the goals and objectives laid out in the plan, with a major update undertaken every five years to establish new objectives and key progress indicators.

MAJOR ATTRIBUTES OF EFFECTIVE UTILITY MANAGEMENT

> ***"Effective utility management can help water and wastewater utilities enhance the stewardship of their infrastructure, improve performance in many critical areas, and respond to current and future challenges. Addressing these challenges also requires ongoing collaboration between government, industry, elected officials, and other stakeholders." – Effective Utility Management: A Primer for Water and Wastewater Utilities[17]***

When developing a climate-resilient BP, water utilities should incorporate the ten attributes of effectively managed utilities[18] as they relate to the adjustments necessary to provide climate resilience within existing business practices:

[17] Utility Advisory Group and Effective Utility Management Collaborating Organizations, *Effective Utility Management: A Primer for Water and Wastewater Utilities* (American Public Works Association, American Water Works Association, Association of Metropolitan Water Agencies, National Association of Clean Water Agencies, Water Environment Federation, and United States Environmental Protection Agency, 2008): 1. http://www.amwa.net/galleries/default-file/Effective-Utility-Management-4color.pdf.

[18] See the website of the American Water Works Association (http://www.awwa.org/resources-tools/water-and-wastewater-utility-management/effective-utility-management.aspx) for documents and toolkits regarding the concept of effective utility management as developed by the American Water Works Association, United States Environmental Protection Agency, and nine other association partners.

MAJOR ATTRIBUTES OF EFFECTIVE UTILITY MANAGEMENT

1. *Product quality* – Will climate change impacts affect our ability to provide high-quality water service delivery to our constituents? What mitigation or adaptation steps must be undertaken to ensure that product quality does not decrease in the future?

2. *Customer satisfaction* – Does our customer base accept our conclusions regarding climate change impacts and are they supportive of the actions being included in the business plan to address these impacts, including any increases in cost?

3. *Employee and leadership development* – In what ways are we training and developing our employees to implement and advance the goals and objectives being developed under the business plan?

4. *Operational optimization* – How have we best optimized operational practices in the face of the anticipated impacts of climate change? What adjustments are required to ensure that operations remain effective and optimized moving forward?

5. *Financial viability* – What is our current financial status and how will finances need to be adjusted to implement those projects prioritized by the VA? Is there a need to seek out new funding sources or have new funding opportunities been made available because of the focus on climate resilience?

6. *Infrastructure stability* – What steps need to be taken to harden existing infrastructure, move, or abandon infrastructure that will be rendered obsolete by climate change impacts, and/or expand infrastructure capacity to meet future challenges?

7. *Operational resilience* – What operational changes need to be altered or enhanced to provide the operational flexibility needed to address climate change impacts?

8. *Community sustainability* – Is the community served by the water utility threatened by the impacts of climate change? Will climate migration occur? How will climate change impacts affect the surrounding watershed and what steps can be taken to counteract or work within those constraints?

9. *Water resource adequacy* – What water resources will be threatened by climate change impacts? What additional sources may be available to expand the diversity of water resources?

10. *Stakeholder understanding and support* – Will community members and leaders support the changes necessitated by climate change impacts? What is the level of trust within the community as it relates to water utility authority regarding water resources and climate change?

Principles of Effective Utility Management[19]

Product Quality	**Customer Satisfaction**
Produces potable water, treated effluent, and process residuals in full compliance with regulatory and reliability requirements and consistent with customer, public health, and ecological needs.	Provides reliable, responsive, and affordable services in line with explicit, customer-accepted service levels. Receives timely customer feedback to maintain responsiveness to customer needs and emergencies.
Employee and Leadership Development	**Operational Optimization**
Recruits and retains a workforce that is competent, motivated, adaptive, and safe-working. Establishes a participatory, collaborative organization dedicated to continual learning and improvement. Ensures employee institutional knowledge is retained and improved upon over time. Provides a focus on and emphasizes opportunities for professional and leadership development and strives to create an integrated and well-coordinated senior leadership team.	Ensures ongoing, timely, cost-effective, reliable, and sustainable performance improvements in all facets of its operations. Minimizes resource use, loss, and impacts from day-to-day operations. Maintains awareness of information and operational technology developments to anticipate and support timely adoption of improvements.
Financial Viability	**Operational Resiliency**
Understands the full life-cycle cost of the utility and establishes and maintains an effective balance between long-term debt, asset values, operations and maintenance expenditures, and operating revenues. Establishes predictable rates—consistent with community expectations and acceptability—adequate to recover costs, provide for reserves, maintain support from bond rating agencies, and plan and invest for future needs.	Ensures utility leadership and staff work together to anticipate and avoid problems. Proactively identifies, assesses, establishes tolerance levels for, and effectively manages a full range of business risks (including legal, regulatory, financial, environmental, safety, security, and natural disaster-related) in a proactive way consistent with industry trends and system reliability goals.
Community Sustainability	**Infrastructure Stability**
Is explicitly cognizant of and attentive to the impacts its decisions have on current and long-term future community and watershed health and welfare. Manages operations, infrastructure, and investments to protect, restore, and enhance the natural environment; efficiently use water and energy resources; promote economic vitality; and engender overall community improvement. Explicitly considers a variety of pollution prevention, watershed, and source water protection approaches as part of an overall strategy to maintain and enhance ecological and community sustainability.	Understands the condition of and costs associated with critical infrastructure assets. Maintains and enhances the condition of all assets over the long-term at the lowest possible life-cycle cost and acceptable risk consistent with customer, community, and regulator-supported service levels, and consistent with anticipated growth and system reliability goals. Assures asset repair, rehabilitation, and replacement efforts are coordinated within the community to minimize disruptions and other negative consequences.
Stakeholder Understanding and Support	**Water Resource Adequacy**
Engenders understanding and support from oversight bodies, community and watershed interests, and regulatory bodies for service levels, rate structures, operating budgets, capital improvement programs, and risk management decisions. Actively involves stakeholders in the decisions that will affect them.	Ensures water availability consistent with current and future customer needs through long-term resource supply and demand analysis, conservation, and public education. Explicitly considers its role in water availability and manages operations to provide for long-term aquifer and surface water sustainability and replenishment.

[19] Adapted from *Effective Utility Management: A Primer for Water and Wastewater Utilities*.

INTEGRATING THE VA AND ADAPTATION OPTIONS INTO THE BP

Water utilities should undertake the following steps when developing their climate-resilient BP:

1. Prioritize projects identified in the VA
2. Assess the current BP for scope and limitations
3. Develop SMART goals and objectives based on a thorough financial assessment
4. Develop an expenditure plan to incorporate climate resilience into existing goals and objectives
5. Develop an assessment process based on the incorporation of key performance indicators (KPIs) to implement the plan.

STEP 1: PRIORITIZE PROJECTS IDENTIFIED IN THE VA

The actions or projects identified in the VA should be prioritized by the senior management team and included in an existing or newly created business plan to enhance a water utility's stance regarding climate resilience. The team responsible for building the climate-resilient BP should first undertake a detailed examination of existing capital and operational needs, as well as the reconciliation of financial realities with adaptation needs. Low hanging fruit and no regrets options should be prioritized and will most likely supplement existing infrastructure needs.

In constructing a capital and operational maintenance plan, it is necessary to prioritize projects and actions based on assessed capabilities. Additional adaptation measures will need to be assessed against basic infrastructure needs, such as reducing NRW, as basic needs may render larger-scale adaptation a luxury at the present time. It is vital to establish the proper balance between climate, non-climate, and necessary operations and maintenance/rehabilitation projects. Lastly, a detailed assessment of funding sources and financial strategies related to climate resilience should be undertaken to enhance current budget projections based on existing sources.

STEP 2: ASSESS THE CURRENT BP FOR SCOPE AND LIMITATIONS

When incorporating climate resilience into a BP, it is important to first clearly define the scope of the document and describe the limitations and additional challenges that face the water utility in developing and implementing projects related to climate change impacts. The scope of the BP should include those areas of focus that are necessary to ensure efficient day-to-day operations within an identified financial framework, while incorporating those priorities identified as part of the VA. The limitations faced by the water utility in implementing the plan should also be identified. These can include financial limitations, political challenges, legal constraints, and/or lack of public trust or support.

STEP 3: DEVELOP SMART GOALS AND OBJECTIVES

Given the short-term (five years with annual assessments) of the climate-resilient BP, the management team should develop and articulate realistic short-term goals and objectives based on the prioritized projects from the VA and a thorough financial assessment of the water utility. The short-term objectives should be based on and incorporate the **SMART** planning framework. SMART planning involves goals and objectives that are:

S – Specific

M – Measurable

A – Achievable

R – Realistic

T – Time-bound

The established goals and objectives should also be translatable into progress indicators (KPIs) that will be developed for the various divisions within a water utility and implemented through performance plans for individual employees. This will enable the management team to embed the principles of the climate-resilient BP throughout the organizational structure, establishing a foundation of ownership for the employees of the water utility and allowing for translation of the goals and objectives within the day-to-day operation of the water utility.

CASE STUDY

Leyte Metropolitan Water District (LMWD)

Description of Problem

The current NRW in the LMWD is in the range of 46 percent to 53 percent. Therefore, out of the monthly production of approximately 2,000,000 m^3, only about 950,000 m^3. is translated into revenue. It is imperative for LMWD to address this problem in order to translate water loss into income.

Description of Business Plan

The plan is to rehabilitate the old pipeline system that was built in the early 1970s. The replacement of the old pipeline system will cost PhP 700,000,000, which is not affordable. A step approach is being undertaken where LWMD is setting a realistic goal of reducing NRW by 4 percent per year for the next five years. The NRW will be reduced through technical and organizational improvements.

<u>LMWD Reduction of NRW</u>

Goal: Reduce NRW and increase billed consumption by 4 percent at the end of 2016.

Activities:

a) Inventory of damaged pipelines undertaken in the first quarter of this year; focus on pipelines located in high-risk areas (steep terrain, inadequate protection, etc.)
b) Assessment of the condition of the water distribution system by first quarter of this year, starting in high-risk areas, followed by areas where the pipelines serve the highest number of customers.
c) Rehabilitation of meter stands and replacement of meters based on age and size of the meters.

d) Repair of leaking service lines, starting with the largest and most apparent leaks.
e) Conduct inspections to identify those who engage in water pilferages; start in areas of known water pilferage.

NOTE: Although the climate-resilient BP should be focused on the short term, it should also allow for longer-term aspirations such as technology innovation and investment, necessary data aggregation, steps towards financial independence or viability, and service area expansion.

STEP 4: DEVELOP AN EXPENDITURE PLAN TO INCORPORATE CLIMATE RESILIENCY INTO EXISTING GOALS AND OBJECTIVES

The management team must ensure that the climate-resilient BP includes a realistic capital investment/expenditure plan that recognizes the current fiscal environment of the water utility. The plan should address challenges and strengthen the financial viability of the water utility. For instance, if a consequential segment of funding comes in the form of grant funding through national or international donor organizations, a plan may include specific actions and objectives that will allow a water utility to work towards financial independence and the ability to rely on more traditional funding apparatuses such as user fees and concessionaire rates. If additional grant funding or other sources are expected to become available due to the focus on climate resilience or for other reasons, those sources should be identified, along with methods to take advantage of those sources.

It is important to recognize the limitations of the current position of the water utility, as well as the future challenges that need to be addressed. For example, current limitations and challenges may be exacerbated by climate change impacts and the adjustments in operations that will need to be made to address them. A climate-resilient BP should be detailed and focused on addressing these challenges. The overarching goals and strategic objectives developed within the plan should include explanations regarding how they will achieve a specific goal or objective. The water utility will then be able to develop the KPIs that will allow management to measure the success being made towards achieving the established goals.

Lastly, it is important to identify the achievements that have already been undertaken by the water utilities through previous plans or actions. Instead of focusing only on challenges and possible shortcomings, identifying successes helps to create confidence and to generate support from stakeholders and government authorities, as well as from employees who will take pride in common successes.

CAPITAL INVESTMENT AND EXPENDITURE PLAN ELEMENTS

Cost and budget forecast:
- Salaries
- Other personnel costs
- Contracted services
- Consumable expenditures

Capital expenditures and investment forecast:
- Capital renewal (underground assets)
- Capital repair and replacement (above-ground assets)
- New capital investments

Revenue needs:
- Debt service
- Capital reserves

STEP 5: DEVELOP AN ASSESSMENT PROCESS BASED ON KPIs

The management team must elaborate on the established goals and objectives by developing KPIs for each of the key areas identified within the plan. The KPIs should also follow the SMART framework, but should be specific to a given division, group or employee. The KPIs will be the connection between the plan and the individual performance plans that make up the performance management aspect of the holistic implementation of the plan throughout the water utility. Although individual performance measures are not included in the climate-resilient BP, the KPIs established in the plan should be detailed enough to allow for rapid integration into the performance plans for employees tasked with implementing the plan.

Once the KPIs are identified, the management team must establish an assessment process to review and update the whole BP. The assessment should occur on an annual basis, ideally at the end of the water utility's fiscal year, to allow for a realistic and accurate financial picture of the previous year. The assessment should include a realistic and detailed investigation of the successes and failures in meeting the established goals and objectives, as well as a review of the success of key groups in meeting their established KPIs. The annual assessment may lead to moderate changes to the BP based on the circumstances of the previous year, but should not lead to a total rewrite of the plan except in severe circumstances. It is recommended that annual performance reviews occur immediately after completion of the annual assessment of the KPIs to cascade the objectives of the plan throughout the organization.

Every five years, the management team should undertake an extensive review of the climate-resilient BP to review and update the entire plan. It is during the five-year review that goals and objectives can be altered, adjusted, or eliminated, and the direction of the water utility can be significantly shifted. During the five-year review, the management team should incorporate input gleaned from throughout the organization to help shape the direction of their organization. This input can be obtained via surveys, employee interviews, employee or stakeholder leadership groups, or through consultation with interested stakeholders. The process for collecting information should be clear and transparent, and the management team should develop a document that provides an explanation and supporting materials regarding what changes and recommendations were being accepted or rejected, and the basis for that decision. This will allow employees and stakeholders to have buy-in to the updates to the plan, and will give them a sense of personal responsibility in the implementation of the updated plan.

One example of a climate-resilient BP that incorporates KPIs is the Palm Beach County Water Utilities Department Strategic Sustainability Plan.[20]

[20] The charts that follow are taken from the Palm Beach County Water Utilities Department Strategic Sustainability Plan (April 2016): 26–29. http://discover.pbcgov.org/waterutilities/PubDoc/PBC_Water_Utilities_Strategic_Sustainability_Plan.pdf.

INITIATIVE: COMMUNITY

TABLE 4: DESCRIPTION OF THE COMMUNITY STRATEGIES

LINE	STRATEGY	PRIMARY KPI	SECONDARY KPI
1	**IMPLEMENT AN ENHANCED COMMUNITY RELATIONS PROGRAM** Develop an enhanced community relations program that includes a proactive community relations strategy that cultivates positive relationships with community stakeholders and regional partners. This will assist in promoting utility programs and foster positive relationships with external stakeholder groups and facilitate support and cooperation on important projects.	• Implementation of an enhanced community relations program (% of target completion for WUD)	• Implementation of a community relations program by element (% of target completion by element)
2	**IMPROVE CUSTOMER ENGAGEMENT AND OUTREACH THROUGH SOCIAL MEDIA, WUD'S WEBSITE, AND OTHER COMMUNICATION CHANNELS** Develop community-based programs and activities through the use of modern communication channels (e.g. website, social media) to increase external and internal stakeholder awareness and interaction. In addition, maintain internal resources and service requirements necessary to meet the needs of the community.	• Customer satisfaction level (overall WUD level) • WUD cumulative customer outreach metric	• Customer satisfaction level (by category or element) • Customer outreach results by category or element

INITIATIVE: ENVIRONMENT

TABLE 5: DESCRIPTION OF THE ENVIRONMENT STRATEGIES

1	**BE AN ENVIRONMENTAL STEWARD IN EVERYTHING WE DO** Implement sustainable and environmentally responsible operating practices and business policies in order to be an environmental steward in everything we do.	• Implement environmentally responsible programs (actual vs. target results)	• Implement environmentally responsible programs within the WUD (actual vs. target results by element) • Energy efficiency program results (actual vs. target results)
2	**ENSURE COMPLIANCE WITH ALL REGULATORY & PERMITTING REQUIREMENTS** Ensure that WUD's operations are consistent with all regulatory and permitting requirements.	• Compliance with all regulatory and permitting requirements (total number of WUD violations)	• Compliance with regulatory and permitting requirements (total number of violations by element)
3	**ENSURE WUD HAS ADEQUATE INFRASTRUCTURE AND RESOURCES TO ADDRESS OR ADAPT TO THE IMPACTS OF CLIMATE CHANGE** As climate change impacts utilities in Florida, ensure that the WUD maintains adequate water supply.	• Establishment of WUD water supply targets based on the Consumptive Use Permit, SFWM drought restrictions, and WUD Flood Management Plan (% completion and/or actual vs. target results)	• Water supply targets based on the Consumptive Use Permit and SFWMD Drought Mandates (actual vs. target Results) • WUD Flood Management Plan targets which include sea level rise (actual vs. target results)

INITIATIVE: INFRASTRUCTURE

TABLE 6: DESCRIPTION OF THE INFRASTRUCTURE STRATEGIES

LINE	STRATEGY	PRIMARY KPI	SECONDARY KPI
1	**OPTIMIZE IMPLEMENTATION OF ASSET MANAGEMENT PLANS (AMP) AND THE CAPITAL IMPROVEMENT PROGRAM (CIP) THROUGH THE USE OF ALTERNATIVE ANALYSIS AND EFFECTIVE PROGRAM MANAGEMENT** Maintain existing assets and develop an appropriate multi-year CIP through advanced planning, alternative analysis, and the implementation of advanced project delivery methodologies.	• Program management performance related to project delivery (overall WUD scores) • Implementation of the overall WUD Asset Management Plan (actual vs. target results)	• Program management performance related to project delivery (overall project element score) • Implementation of the overall WUD Asset Management Plan by element (actual vs. target results by element)
2	**INNOVATE THROUGH THE IMPLEMENTATION OF INDUSTRY-LEADING TECHNOLOGIES TO BECOME A SMART UTILITY** We must continue our history of innovation through the implementation of relevant technologies that will result in WUD becoming an industry-leading smart utility.	• WUD SMART utility plan implementation (% of target completion dates met)	• WUD technology assessment target results by element (actual vs. target results) • Implementation of SMART utility plan projects (% of target completion dates met)
3	**MAINTAIN ADEQUATE SERVICE CAPACITY FOR ENHANCED EMERGENCY AND SECURITY PREPAREDNESS AND RESPONSE IN CASE OF UNEXPECTED EVENTS** Ensure that our ability to maintain the required level of service and effective response to unexpected emergencies and events is not jeopardized.	• Review the existing WUD Emergency and Security Preparedness Plan to establish effective emergency response policies, procedures, and protocols as necessary (% of target policies, procedures, and protocols met)	• Review the existing WUD Emergency and Security Preparedness Plan be element to establish effective emergency response policies, procedures, and protocols as necessary (% of target policies, procedures, and protocols met)

INITIATIVE: WORKFORCE

TABLE 3: DESCRIPTION OF THE WORKFORCE STRATEGIES

LINE	STRATEGY	PRIMARY KPI	SECONDARY KPI
1	**ENHANCE EMPLOYEE DEVELOPMENT AND IMPLEMENT A KNOWLEDGE TRANSFER PROGRAM** Implement employee development and knowledge transfer programs, including job rotation and knowledge capture sessions. This will provide growth and development opportunities for our employees, increase the level of business and technical competencies within WUD staff, and address key employee retirements.	• Department workforce performance score (Overall WUD Score)	• Progress towards implementation of individual development plans (% completion of KPIs included in individual development plans) • Employee training (% of employees receiving as Least 40 hours of training per year) • Progress towards the implementation of management/key positions succession and knowledge transfer plan (% achievement to implement a succession plan and the closure of enterprise level competency gaps)ensure a safety-first culture, and improve employee engagement and teamwork.
2	**DRIVE ACCOUNTABILITY AND TRANSPARENCY** Ensure that we are a performance- driven utility, with transparency regarding expectations and actual employee performance.	• Department workforce performance score (overall WUD score with regards to performance accountability and expectations transparency)	• Progress towards implementation of individual development plans (% completion of KPIs included in individual development plans)
3	**IMPROVE EMPLOYEE ENGAGEMENT, INTERNAL DEPARTMENT COMMUNICATION AND COLLABORATION, AND REWARD EMPLOYEE PERFORMANCE THROUGH INCREASED RECOGNITION** Develop proactive measures to increase employee engagement, facilitate internal Departmental communication, and promote collaboration and teamwork. Provide multiple mediums for employees to communicate their level of engagement, satisfaction, and ideas for improvement. In addition, regularly celebrate employee performance using formal and informal means of recognition, focused on driving the WUD Mission.	• Department workforce performance score (overall WUD score with regards to employee engagement and collaboration)	• Employee engagement and collaborative performance score (workforce engagement and collaboration survey - scores by element)
4	**DEVELOP A SAFETY-FIRST CULTURE TO IMPROVE EMPLOYEE HEALTH AND SAFETY IN THE WORKPLACE** Make employee health and safety a top priority in everything we do	• Overall WUD safety score (Composite WUD Score: OSHA safety benchmarks and/or audit and WUD established safety metrics)	• Overall safety score by element (composite score by element: OSHA safety benchmarks and/or audit, and WUD established safety metrics)

CASE STUDY
ISABELA WATER DISTRICT (ISAWAD)

Goals
Under the Results Matrices prepared by the National Economic Development Authority (NEDA) to foster inclusive growth and poverty reduction, the water districts under the guidance of the Local Water Utilities Administration (LWUA) are expected to achieve two major goals:

(1) Accelerate **infrastructure development** in terms of enhancing quality, adequacy and accessibility of water supply and sanitation facilities as well as services through any of the following:

- Improving access to water supply and sanitation services
- Improving environmental quality, particularly water quality
- Increasing resilience of water utilities to climate change and natural disasters

(2) Promote **social development** specifically by improving human development status in terms of providing improved access to quality health and nutrition services through water supply and sanitation facilities.

With the recent completion of the Climate Change VA for the water districts in partnership with the USAID Be Secure Project and WaterLinks through the PAWD COP-CC, a major goal has been identified for the water district to take into account in its operation given the projected changes in climate: the goal of **building the water district's resilience to climate change and disaster hazards and risks**. This is the third major goal for the water district.

Strategies
To attain the goals and objectives mentioned, the following strategies will be implemented by the water district:

Goal 1: Accelerating infrastructure development

- Increase percentage of population with access to level I and II potable water supply systems to 90 percent.
- Increase percentage of population with access to level III potable water supply systems to 80 percent.
- Increase percentage of households with 24/7 water supply service to 100 percent.
- Increase percentage of household population covered by septage management systems to 80 percent.

Goal 2: Promoting social development

- Increase percentage of household population with access to safe water to 90 percent.
- Increase percentage of household population with access to sanitation facilities to 80 percent.
- Increase access of schoolchildren to water and sanitation facilities in schools.

Goal 3: Building resilience to climate change and disaster hazards and risks

- Increase resilience of water supply sources to hazards and risks of severe temperature and extreme rainfall.
- Increase adaptability of infrastructure facilities to hazards and risks caused by extreme rainfall, typhoons, and other climate and weather disturbances.
- Increase availability of water supply during emergencies through portable and standby facilities.

Demand Analysis and Forecast

The climate-resilient BP should contain detailed demand analyses and a forecast of future demands within a reasonable time frame that reflects the short-term demand needs within the context of the current plan (five years), as well as longer-term demand calculations (i.e., 20 years).

To calculate the future water demand, the management team should aggregate and evaluate production and water sales that have been collected by water utility staff. Additionally, staff should develop future demand projections based on anticipated population increases, efficiency gains (i.e., NRW reduction), existing capacity analyses, anticipated growth within this system, and existing and anticipated allocations. For the purposes of this toolkit, it is anticipated that the demand analysis and forecast for the climate-resilient BP will build upon previous projections developed by the water utility for previous business plans, and will incorporate those climate change impacts likely to shift the projected future demands of the water utility. Additionally, this exercise should also include a section that provides a regulatory analysis of existing rules and regulations that impact demands or allocations, as well as anticipated regulatory actions that require future planning within the context of the BP. Upon completion of the demand analysis and forecast, the management team will determine the key planning parameters regarding demand management for inclusion in the plan.

Forecast and demand assumptions drive outcomes and will impact the entire plan, especially once climate change impacts are taken into consideration. These assumptions will cascade through subsequent planning decisions, so it is vital that the management team take every necessary precaution to develop the most accurate information possible.

Adequate and accurate data and analyses are key to future business planning, particularly in the face of certain climate change impacts (such as drought, increased demand due to heat, saltwater intrusion, etc.).

Organizational Structure/Staffing Needs

In incorporating climate resilience and the recommendations/priorities that come out of the VA into the climate-resilient BP, the management team should undertake an assessment of current staffing levels and organizational structures to determine whether reorganization is needed and where additional hiring or transfer of positions or resources may be necessary to implement climate resilience within the water utility. The team member that is directing the development and implementation of the climate-resilient BP should meet with the Human Resources team to determine:

- Are staffing levels adequate?
- Are the right people in the right roles?
- How are different areas integrated?
- Are levels of education and technical training adequate?
- Is succession planning in place?
- Is the organizational structure too top-heavy? What is the distribution of managerial responsibility?
- Are the lines of authority and communication clearly articulated and efficient?

The meeting should take place after the establishment of the goals and strategic objectives as part of the planning process, and should be part of the establishment of KPIs for the organization. The goal of the assessment is to develop the structure and communication links necessary to embed climate resilience throughout the organization and to allow for leadership to develop throughout the organization from top-down, bottom-up, and across departments.

Financial Forecast/Statements/Revenue Needs

The management team needs to reassess existing financial forecasts and revenue needs in order to integrate priorities identified by the VA into existing financial planning that provides for traditional capital improvements, refurbishment and replacement, operations and maintenance, and administrative financing. **This financial analysis and subsequent adjustment should be undertaken as one of the *first* steps after constitution of the management team to develop and implement the climate-resilient BP.** The resulting forecast will inform the goals and strategic objectives of the water utility during the five-year planning period and will provide a pragmatic grounding to what can actually be accomplished.

Why have a financial plan that includes climate resilience?

Having adequate financial resources is important if you are going to meet the ultimate goal of maintaining an adequate and sustainable supply of safe drinking water and a reliable wastewater system for your customers. Although a water utility may already have excellent operators, a plentiful supply of high-quality water, good infrastructure to store and deliver the water, and a properly functioning wastewater system, healthy fiscal stability and planning are still necessary to sustain quality operations. Climate resilience is part of that healthy fiscal planning framework.

A financial plan should include:

- Realistic revenue assumptions
- What are revenue needs?
- Debt analysis – salary and workforce budget analysis
- Alternative funding sources and availability
- Asset management (data)

- Integrated management of capital projects to determine future revenue needs
- Factors impacting future expenditures
- Trend analysis utilizing previous budgets
- Analysis of external factors that impact finances, such as conservation, efficiency gains, etc.

In incorporating climate resilience and the results of the VA into the five-year financial plan, the water utility should include:

a) Capital expenditures (including for hardening and resilience projects)
b) Operating and maintenance budget
c) Revenue needs and projections
d) Tariff policy and strategy

(a) Capital Expenditures Analysis

Simply planning for capital investment is insufficient for sound water utility management. The BP should express a degree of certainty as to the source of the investment funds, the terms of those funds to be offered, and the timing of when those funds might come available, such that their beneficial use can be realistically reflected in the BP.

The capital expenditures analysis should include:

- Capital renewal (underground assets) – Although all assets are amortized based on standards of accounting, for a water utility, such amortization may not reflect a practical reality. Some pipelines may fail at any time due to conditions both inside and outside the pipeline, whereas others will be fully functional for periods of time well beyond their "accounting" useful life. Management needs to consider capital renewal expenditures for underground assets on an expense basis based on its knowledge of the condition of these assets and input of the teams and operators on the ground.

- Capital repair and replacement (above-ground assets) – When considering operating equipment and structures (above-ground assets), the management team will need to consider individual amortization rates for each piece or groups of equipment or structures, in addition to an agreed-upon water utility life span. For a water utility that is operating normally, capital renewal and capital repair and replacement expenditures are largely funded from the cash flow of the water utility's tariff structure, and not from the creation of debt.

- New capital investments – New capital investments are made to permanently enhance service levels in the existing systems (i.e., 24-hour service), including the provision of climate-resilient water utility services as a result of the implementation of the recommendations of the VA. Additionally, new capital investments should cover the expansion of the system to currently unserved areas of the population or to ensure full service (without interruption) to underserved customer areas. Capital expenditures are commonly done with grants, debt (credits/loans) and cash (budgeted capital expenditures).

- Process/assumptions to build the capital investment/expenditure plan – The management team and financial executives at the water utility should utilize a Capital Investment Program worksheet (see example) to develop their capital expenditure plan. Management will determine the level of annual capital expenditure under the renewals budget it deems it can or must spend

for buried/underground assets and capital repair and replacement, as well as integrate necessary measures for climate resilience. These expenditures can start out rather small and increase to the ideal level over time. Management should also determine the annual amounts for future new capital investments. After determining the annual amounts, the management must decide on financing sources to meet all of its new capital investment needs

Sample Capital Expenditures Plan

Item	Qty.	Unit Cost	Total Cost Year 1-5	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
Capital Renewal									
Source Facilities	1	LS	**0**						
Treatment Facilities	1	LS	**5,700**	200	500	5,000			
Transmission Mains	1	LS	**13,200**	800	1,000	2,400	3,000	3,000	3,000
Distribution System	1	LS	**0**						
Valves	1	LS	**0**						
Total Capital Renewal Expenditures			**18,900**	**1,000**	**1,500**	**7,400**	**3,000**	**3,000**	**3,000**
Capital Repair and Replacement									
Fixed Operating Equipment		LS	**1,680**	100	250	500	500	230	100
Moveable Operating Equipment		LS	**0**						
Office and Laboratory Equipment		LS	**0**						
Buildings		LS	**150,000**	150,000					
Structures (tanks)		LS	**0**						
Total Capital Repair and Replacement Reserve			**151,680**	**150,100**	**250**	**500**	**500**	**230**	**100**
New Capital Investments									
New Project 1		LS	**3,000,000**	1,000,000	1,500,000	500,000			
New Project 2		LS	**800**	500	300				
New Project 3		LS	**0**						
New Project 4		LS	**0**						
New Project 5		LS	**0**						
New Project 6		LS	**0**						
Total New Capital Investments			**3,000,800**	**1,000,500**	**1,500,300**	**500,000**	**0**	**0**	**0**
Contribution to New Capital		LS	1,200	500	500	200			

Item	Qty.	Unit Cost	Total Cost Year 1-5	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
Investment Reserve									
New Capital Investment Loans		LS	200	100	100				
Total Capital Investments from Free Cash Flow			**171,780**	**1,151,600**	**1,502,050**	**507,900**	**3,500**	**3,230**	**3,100**
Capital Investments from Grants									
Total Capital Investments from Grants			**0**	**0**	**0**	**0**	**0**	**0**	**0**

(b) Operations and Maintenance (O&M) Budgeting

The O&M budget is a detailed expenditure plan of the labor, material, energy and other expenses needed to produce and sell water or collect and treat wastewater. Management needs to understand how expenditures have been made over the last several years. Historical costs are also needed in order to determine the proper levels of service required over the five-year planning period, and to determine how climate change impacts may affect the required levels of O&M expenditures moving forward. In order for the climate-resilient BP to be successful, the management team must understand the current and future needs of the water district, including those needs identified in the VA. To do this, managers need to rely heavily on staff to make projections since they are the ones who have an understanding of what is needed to keep the system operating reliably. As an example, management needs to consider trends in power, chemical costs, etc.

Example: LMWD O&M budget

Expenses	Year 2015	Year 2016	Year 2017	Year 2018
Salaries	**Base Year** (PhP)	(PhP)	(PhP)	(PhP)
Annual Base Salary	54,237,231	60,361,401	69,415,611	79,827,953
Overtime	4,748,567	3,282,629	3,446,761	3,619,099
Year End Bonus	3,170,907	3,356,273	3,859,714	4,438,671
Mid-Year Bonus	3,170,907	3,356,273	3,356,273	3,356,273
Bonuses	8,555,940	8,918,304	9,007,487	9,097,562
Other Compensation	7,657,400	7,536,700	7,762,801	7,995,685
Board of Directors' Compensation	831,168	831,168	831,168	831,168
Other Board Members' Compensation	198,000	198,000	198,000	198,000
Sub Total (1)	***82,570,120***	***87,840,749***	***97,877,815***	***109,364,411***
Personnel Costs				
GSIS	4,189,520	4,976,291	5,711,061	6,567,720
Phil health	429,544	469,850	513,938	562,163
Pag-ibig	169,200	178,400	181,968	185,607

Expenses	Year 2015	Year 2016	Year 2017	Year 2018
Employee Compensation	169,200	177,200	184,288	191,660
Training	1,503,400	1,889,200	2,374,003	2,983,216
Sub Total (2)	***6,460,864***	***7,690,941***	***8,965,259***	***10,490,367***
Expenditures				
Maintenance	9,936,191	6,546,406	7,528,367	8,657,622
Materials	10,128,535	7,122,048	8,190,355	9,418,908
Chemicals	15,139,175	18,489,100	19,413,555	20,384,233
Electrical Energy	8,193,445	5,290,573	5,396,384	5,504,312
Security Services	14,458,517	15,181,443	15,940,515	16,737,541
Other Contracted Services	14,297,920	14,297,920	14,297,920	15,012,816
Transport (fuel, oil, vehicle insurance)	12,651,949	6,855,790	7,198,579	7,558,508
Office and Administrative	5,636,522	22,202,050	23,312,152	24,477,760
Taxes (Premiums and other fees)	250,000	8,983,400	9,432,570	9,904,199
Purchased Water	0	0	0	0
Other Expenditures	5,385,840	12,038,426	12,038,426	12,038,426
Public Relations	1,207,500	1,489,070		0
O&M Contingency	3,000,000	2,000,000	2,000,000	2,000,000
Sub Total (3)	***100,285,593***	***120,496,225***	***124,748,824***	***131,694,324***
Total O&M Costs (1+2+3)	**189,316,577**	**216,027,914**	**231,591,897**	**251,549,102**

(c) Revenue Needs

Revenue needs represent a sum greater than the routine O&M expenditures of the water utility and should include all those expenditures necessary to achieve the requirements of the climate-resilient BP. Revenue needs also include allowances for interest payments on loans and principal repayments of loans, planned capital expenditures for renewal of buried infrastructure, contributions to capital repair and replacement reserves, and contributions to new capital projects as prioritized as a result of the VA.

A revenue needs analysis should include the following:

- Interest on outstanding or near-term debt
- Principal repayments on outstanding or near-term debt
- Debt repayment reserves
- Allowances for annual planned capital renewals
- Contributions to capital repair and replacement reserve
- Contributions to new capital investment reserve
- Existing subsidies from central/local governments and/or international sources

Example: LMWD Revenue Needs Budget

Description	Year 2015	Year 2016	Year 2017	Year 2018
	Base Year (PhP)	(PhP)	(PhP)	(PhP)
Total O&M Costs (1+2+3)	**189,316,577**	**216,027,914**	**231,591,897**	**251,549,102**
Debt Service				

Description	Year 2015	Year 2016	Year 2017	Year 2018
Interest Payments from Revenues	58,447,397	60,000,000	58,200,000	56,454,000
Principal Repayment from Revenues	50,365,841	78,360,000	83,820,000	89,662,200
Debt Repayment Reserve	0	0	0	0
Sub Total (4)	**108,813,238**	**138,360,000**	**142,020,000**	**146,116,200**
Capital Expenditures				
Capital Renewal Expenditures	0	20,058,500	15,058,500	0
Capital Repair and Replacement Reserve	6,675,000	14,540,000	5,640,000	1,800,000
New Capital Investment Reserve	0	1,095,000	1,095,000	3,750,000
Sub Total (5)	**6,675,000**	**35,693,500**	**21,793,500**	**5,550,000**
Subsidies				
Subsidies from Central/Local Government	0	0	0	0
Sub Total (6)	**0**	**0**	**0**	**0**
Total Revenue Needs (1+2+3+4+5-6)	**304,804,815**	**390,081,414**	**395,405,397**	**403,215,302**
Collection Efficiency (% per Year)	90%	90%	90%	90%
Adjusted Total Revenue Needs with the Collection Efficiency	**338,672,017**	**433,423,793**	**439,339,331**	**448,017,002**
Debt Service Reserve				
(O&M Contingency+Debt Repayment Reserve+Capital Expenditures)	9,675,000	37,693,500	23,793,500	7,550,000
Total Debt Service Reserve (as % on Adjusted Total Revenue Needs)	4.02%	14.47%	7.05%	1.87%

(d) Tariff Policy and Strategy

Once a realistic mean tariff has been calculated, a pricing strategy can be developed to reflect any differentiations among classes of customers, and to ensure that the needed revenues will actually be generated so that the water utility is financially and commercially viable. This condition must be met, whether the water utility is operated "publicly" or under a contract with a private entity. In adjusting an existing tariff policy to incorporate climate-resilience measures, the water utility should consider those benefits accruing in both the short and long term to the customers impacted by the improvements.

For example:

SPECIFIC LOCAL CONDITION	CORRESPONDING TARIFF POLICY
Abundant water	Encourage water consumption and sales
Limited water supply	Encourage water use conservation
Largely variable seasonal demand	Conserve usage in high season, encourage usage in low season
High fixed cost	Consider both fixed and variable costs in rate

SPECIFIC LOCAL CONDITION	CORRESPONDING TARIFF POLICY
Customer group with low ability to pay	Off-set rates to subsidize customers
Customer categories have similar usage patterns	Apply a uniform pricing strategy

Selecting a tariff structure requires the management team to define the goals and objectives of the tariff structure and evaluate the available alternatives in meeting these goals and objectives. Once the framework and structure have been developed, it is the responsibility of the management team to develop an outreach and communications strategy to explain the potential effects to customers and stakeholders. In some cases, the selection of a tariff structure is heavily regulated and limited by national policy and oversight. For example, tariff setting methodology in the Philippines is specifically defined by the LWUA for water districts and local government units (LGU), and by the National Water Regulatory Board (NWRB) for private water utilities.

Some examples of tariff structures include:

RATE TYPE	APPLICABILITY
Uniform	• Similar usage patterns amongst groups • Varying rates are undesirable from an equity perspective • Cost and usage data by customer are unavailable • Other rate structures are not justifiable
Declining Block	• Water supplies are plentiful • Production costs respond favorably to economies of scale • A single rate structure is used for all customer classes of service • Higher initial costs for the first slug of consumption and then decline as usage increases • System has an array of customers with varying usage and demand requirements • Seldom used since it promotes higher and inefficient water usage
Increasing Block	• Able to distinguish separate customer category • Analytical ability to design rate structure and determine usage • System capacity constraints or potential system expansion • Sends a strong price signal and promotes water efficiency and water conservation

RATE TYPE	APPLICABILITY
Seasonal	• There is substantial variation in water demand across seasons • Capacity constraint during peak-period demands • System experiences seasonal fluctuations in the number or type of customers served
Combined Fixed and Volumetric	• Consumption rates vary and utility wants to have a more uniform cash flow • Certain charges are fixed (service/meter charge) and are based on customer and not usage • Can be combined with increasing block rate
Non-Metered	• Customers without meters • Cost based on number of inhabitants and living space • Eliminates cost of meter maintenance and reading

While many of these structures may be applicable within a specific local context, several may be more desirable when considering longer-term impacts of climate change. For example, if longer drought conditions are anticipated, an inclining block rate combined with a seasonal rate for low supply/high demand periods may be desirable in achieving necessary conservation rates to help address drought impacts.

Most importantly, the calculation of the average tariff for a cubic meter of water is important since it functions as a benchmark for present and future consideration in developing the tariff structure and in assessing the water utility's progress in managing or reducing costs.

Indicators for Progress Measurement (KPIs)

As noted above, the establishment of SMART KPIs translates strategic objectives into concrete and measurable actions. The water utility realizes the benefit of being able to document the success/failure of each strategy through the efforts of specific teams and individual employees. KPIs should:

- Provide accountability throughout the organization
- Provide leadership opportunities and reward initiative and innovation

In designing KPIs, the management team and individual leadership teams should work towards establishing standards that sustain the success of the water utility as opposed to focusing on the regulation of the individual worker. Although the individual worker will be held accountable for his/her responsibilities in achieving a particular set of KPIs towards a strategic objective and goal, the larger focus is on the integrated success of the water utility through the implementation of KPIs through coordinated units. Established KPIs should reflect those skills needed in a particular focus area to achieve a specific strategy, and should enable the management team to direct resources to the areas of education and technical advancement necessary to improve the core skills of employees within the water utility to achieve the identified KPIs.

Annual Assessment and Adaptive Management Measures

Although the climate-resilient BP has a five-year duration, it is necessary to review the plan annually to assess the incremental progress towards the goals and strategic objectives articulated in the plan, determine the effectiveness of the KPIs, and make any changes necessary to any portions of the plan.

For instance, if a major new funding source becomes available, the management team will need to determine how to prioritize expenditures for that new source and adjust other components of the BP accordingly. The management team is recommended to undertake the assessment at the end of each fiscal year during annual performance reviews and other annual administrative housekeeping procedures.

The climate-resilient BP should establish in detail the specific process for the annual assessment and update of the plan. A Climate Resilience or Planning Officer should be designated by the management team and tasked with initiating the plan review process and convening the team designated with undertaking the assessment. The assessment should flow from the KPIs that have been established for progress measurement and should be flexible enough to provide for the effective adaptive management of all aspects of water utility operations.

The process should include details regarding how the assessment is to be undertaken, within what time period, and how the recommendations stemming from the assessment are to be approved by the management team and lead to the amendment of the climate-resilient BP. Each recommendation should be tied to the adaptive management of a specific five-year goal or strategic objective as originally articulated.

NOTE: The annual assessment and amendment process is *not* a wholesale rewriting of the plan, which should happen every five years. Holistic alterations and amendments of the BP should only be made during an annual assessment if there is a substantial shift in the circumstances of the water utility. In this circumstance, a new plan should be developed and the five-year time period should be reset. Progress towards meeting longer-term goals should be noted in the assessment process but should not be specifically addressed or amended until the rewrite of the BP in year 5.

The annual assessment and recommended changes should be utilized by the management team as a way to undertake outreach to customers and stakeholders to emphasize the accomplishments of the water utility and to demonstrate how actions being undertaken are directly linked and integrated into a holistic and progressive plan.

OUTREACH

Although not necessarily included in the body of the climate-resilient BP, a water utility will need to develop support from stakeholders, local government leaders and business representatives within the community to contribute to continued assessment of climate impact risk and the prioritization of projects and planning efforts within the context of normal business planning.

Outreach will play a major role in building and maintaining support for necessary projects and associated funding commitments. The planning efforts will create a common understanding among the various partners and stakeholders about how the region's climate may change in the coming decades. It may be important to identify a climate "champion" within executive leadership or on the governing board of the public water supply entity. Lastly, it is vital to identify and understand the audience for outreach efforts so that any messaging can be designed to target their basic interests and areas of concern. Key aspects of messaging include:

- Describe current conditions and existing challenges (can be straight out of the BP)
- Describe changes that have already been observed
- Describe changes that are expected
- Describe how climate change will impact the water utility and them as stakeholders
- Convey the need for action (*however, make sure to balance challenges and need for action with optimism*)
- Identify other similar communities that are also including climate resilience within business planning efforts (emphasize communities of partnership where available)
- Set out a clear and concise course of action
- Acknowledge that questions remain
- Keep things simple!

After developing the outreach method(s), determine how to undertake the outreach, both within the organization and with external stakeholders. Methods of communication can include lunch presentations, department meetings, scientific briefings, newsletters and fact sheets, websites, public meetings, press releases, media training events, and/or events aimed at business interests and NGOs.

SECTION 3 – EMERGENCY RESPONSE PLANS

Even with a mature and effectively implemented BP that incorporates climate resilience, there will be those emergency events that will test the responsiveness and capabilities of a water utility. It is essential for a water utility to have a well-developed ERP that will allow it to respond rapidly and effectively to emergency events. While an effective BP will provide the essential resources that will allow for effective emergency response, the ERP will provide the "detailed playbook" by which a water utility deploys resources and manpower in response to an emergency event.

The ERP should allow for military precision in responding to an emergency event and should make regularly occurring events (for instance, a Signal 2 storm event) relatively easy to respond to, allowing for greater flexibility when major emergency events occur.

NOTE: When significant emergency events occur, the ERP will provide the foundation for emergency response; however, there will be times when the ability of a water utility to respond to an emergency event may be compromised. On those occasions, the management team and senior leaders of a water utility will be forced to rely on other partners and aid groups or agencies. It is in the time of a severe emergency event that established partnerships and mutual aid agreements become vitally important.

ERPs should be based on known and anticipated events. The VA should be utilized to provide the basis for the identification of events related to climate change as well as anticipated changes in the severity of impacts as the effects of climate change become more pronounced (e.g., longer droughts, heightened storm frequency, etc.). An ERP should have a specific set of implementation criteria and action plans for each specified emergency event. They should always contain three parts: personnel procedures; facilities, equipment and materials procedures; and special/targeted notes and procedures. The last category can function as a "catch all" for miscellaneous manuals, procedures, forms, agreements and policies that need to be aggregated but do not have a specific area of focus.

The first step when developing an ERP is to conduct a risk assessment to identify potential emergency scenarios. The risk assessment can be based on and build upon the VA undertaken as part of the development of the climate-resilient BP. It should additionally include a detailed inventory of items necessary to respond to an emergency event, as well as a step-by-step assessment of existing response plans to identify gaps and shortcomings. An understanding of what can happen will enable the emergency management team to determine resource requirements and to develop plans and procedures to prepare for that eventuality.

The ERP should be consistent with the performance objectives established in the climate-resilient BP. When an emergency occurs, the first priority is always life safety. The second priority is the stabilization of the incident. There are many actions that can be taken to stabilize an incident and minimize potential damage. Some severe weather events can be forecast hours or days before they arrive, providing valuable time to prepare for the event and take necessary steps to protect facilities and vital infrastructure. A plan should be established and resources should be on hand or quickly available to prepare for an emergency event. The plan should also include a process for damage assessment, salvage, protection of undamaged property, and cleanup following an incident. These actions will minimize further damage and business disruption while allowing a water utility to efficiently respond to its concessionaires to ensure that high-quality water service continues through an emergency event or is restored shortly after an emergency event if it is lost during the event.

Who creates and maintains an ERP?

An ERP must be an organic document created by those with the greatest institutional and organizational knowledge within the organization. ***It is important that the ERP serve as a stand-alone document that contains all the necessary information and procedures.*** Its development depends on input from the employees responsible for repairing and rehabilitating the infrastructure up to the board members that are responsible for setting policy at the highest level.

The team responsible for creating and maintaining an ERP should include:

- Management
- Operators
- Board members
- Technical experts

The ERP Management Team should be kept to a smaller number of participants that will be responsible for major decisions; any broader questions should be vetted through larger leadership teams that include on-the-ground participants dispatched during and after emergency events to respond and recover. The Management Team should consist of no more than 15 participants, with the larger leadership groups numbering as many as necessary to address the technical requirements of emergency response. The ERP team should meet regularly (i.e., at least once per month and possibly more often if necessary) when developing or assessing the existing ERP. The larger leadership team should meet at least once a quarter and more often if needed to address challenges or issues arising from an assessment or emergency event. It is recommended that the ERP Management Team undertake the assessment of the existing ERP at least once a year, preferably while the water utility undertakes the desktop emergency exercise so that the larger leadership team can be actively involved in testing the existing ERP. The desktop emergency exercise should be undertaken at the beginning of the year when a water utility can anticipate the greatest threat of an emergency occurrence (i.e., drought or typhoon). Lastly, the team should undertake an assessment of the responsiveness of the implementation of the ERP immediately after stabilization of the water utility following an emergency event.

STEP-BY-STEP COMPONENTS OF AN ERP

The ERP provides the basic blueprint for a water utility to respond to any emergency that may impact the water utility and its ability to provide potable water service. Many of these impacts will become more severe due to climate change. The ERP should set out detailed information regarding how the water utility will act as a unified and coordinated team in the event of an emergency, what equipment will be used and where, and how the water utility will recover after the conclusion of an emergency event.

ELEMENTS OF AN ERP

a) Introduction
b) Emergency Planning Information
c) Water District Information
d) Emergency Operations
e) Emergency Action Plans (3 "W"s – Who, What, Where)
f) Response and Recovery
g) Updating and Training

The ERP management team should construct the basic framework of the ERP. Sub-teams that include individuals involved in operations, procurement, human resources, and other technical experts are then responsible for populating the details of the document and identifying areas where gaps may exist. An initial desktop exercise simulating an emergency event may be useful when undertaking the initial construction of the ERP and to find and fill gaps (see page 83 for an example of a desktop exercise to stress test the ERP). It is important to note that an ERP will

mature over time as water utilities undertake desktop simulations, annual assessments of the ERP and respond to actual emergency events. After each event, gaps and nuances should be identified and the ERP should be modified to respond to the identified shortcomings.

The ERP should include the following sections:

a) INTRODUCTION

Set out the purpose and objectives of the ERP document.

For example:

The purpose of this ERP is to provide the water utility with a standardized response and recovery protocol to prevent, minimize, and mitigate injury and damage resulting from emergencies or disasters of man-caused, natural, or dependency/proximity origin.

Objectives:

- Rapidly restore water service after an emergency.
- Ensure adequate water supply for fire suppression.
- Minimize water system damage.
- Minimize impact and loss to customers.
- Minimize negative impacts on public health and employee safety.
- Provide emergency public information concerning customer service.

CASE STUDY

CAGAYAN DE ORO WATER DISTRICT (COWD)

Introduction to ERP

The purpose of the ERP is to provide the COWD with a standardized response to emergencies and calamities, specifically typhoons and flooding, as well as droughts that may form as the result of the El Niño Southern Oscillation (ENSO). The ERP was developed from the experience of COWD during its response and recovery efforts as the result of impacts from Tropical Storm Sendong in December 2011 and Typhoon Pablo in December 2012. The action plan for droughts section was developed using the experience of COWD during the occurrence of ENSO in 2015-16. The ERP is created to prevent, minimize, and mitigate injury to personnel and damage to vital facilities during typhoons and droughts.

The objectives of the COWD ERP are the following:

1. Rapidly restore water service after an emergency;
2. Minimize damage to vital facilities during an emergency;
3. Mitigate the impact of disasters on water users;
4. Minimize injuries to employees during an emergency;
5. Minimize negative impact on public health;
6. Provide efficient information dissemination to stakeholders.

b) EMERGENCY PLANNING INFORMATION

The ERP should contain an initial section that details all the necessary general information required to respond to an emergency event, including contact numbers, legal agreements, financial information, etc. These can be utilized by an active participant during the execution of their responsibilities. The development of the emergency planning information should initially be undertaken by the ERP Management Team and then submitted to the larger leadership team for their input. The operators and responders on the ground during an emergency event will be in a position to better inform the team of those contacts and procedures necessary during the implementation of the ERP.

GENERAL INFORMATION

The section containing general information should include contact numbers for everyone involved in the emergency response, including:

- All facilities
- All vendors or partners
- NGOs
- Relevant key local partners (local governments, regional agencies, hospitals, and other sensitive critical facilities, etc.)

The general information should also provide:

- An overview of the emergency scenarios contemplated by the ERP
- The schedule for assessment and revision
- An organizational chart of key personnel
- Any other information that is determined by the ERP Management Team to be necessary for the successful execution of the ERP

PLANNING PARTNERSHIPS

The ERP should list those organizations that the water utility collaborated with in developing the ERP. It should also include established emergency planning partnerships with other parties who have agreed to coordinate with the water utility in an emergency.

For example, a water utility should identify the emergency operations division of an associated local or regional government entity and indicate how and when to communicate with the entity during an emergency event.

Also, identify whether the water utility will have an employee housed at a local or regional Emergency Operations Center during an emergency.

Examples of planning partnerships to be listed include: local emergency management, fire departments, health agencies, NGOs, and other water utilities or companies.

EXAMPLE: ISAWAD

ISAWAD DESCRIPTIONS OF ARRANGEMENTS WITH LOCAL AUTHORITIES

PLANNING PARTNERS	SELECTED SCOPE OF INVOLVEMENT							AUTHORIZED REPRESENTATIVE, ADDRESS, AND CONTACT INFORMATION
	I. SUPPORT FOR TRANSPORT AND EQUIPMENT REQUIREMENTS	II. SUPPORT FOR MATERIALS, SUPPLIES AND OTHER SERVICE REQUIREMENTS	III. SUPPORT FOR OTHER LOGISTICAL REQUIREMENTS	IV. SUPPORT FOR INFORMATION AND COMMUNICATION	V. SUPPORT FOR SECURITY AND ORDER	VI. SUPPORT FOR PERSONNEL	VII. OTHER SUPPORT	
NATIONAL GOVERNMENT OFFICES (LOCAL)								
Department of Public Works and Highways - District Engineering Office	✓							**ENGR. BENSALI A. KASIM** Tabuk Barangay, Isabela City **0917-653-7117** (Administrative Section)
Department of Transportation - Philippine Coast Guard - Isabela Sub-Station	✓	✓				✓	✓	**PO2 NUR-INA U. BASIRUL** Seaside Barangay, Isabela City **0916-6813-941**
Department of the Interior and Local Government - Bureau of Fire Protection - Isabela City Fire Station	✓	✓	✓	✓		✓		**F/INSP. JASMIN S. TANOG** Sunrise Barangay, Isabela City **0995-096-4783**
Department of Health - Basilan General Hospital						✓	✓	**DR. RIZALINO W. PAJARITO** Km 2 Binuangan Barangay, Isabela City **0917-632-0416**
Philippine Information Agency - Basilan Information Center				✓				**MR. RENE V. CARBAYAS** Isabela City Infirmary Bldg., Sunrise Barangay, Isabela

								City **0917-885-7321**

Mutual Aid Agreements

The ERP should list any mutual aid agreements that have been executed between a water utility and other parties. The purpose of mutual aid agreements is to provide needed assistance during an emergency event without going through a formal agreement process on a case-by-case basis. Establishment of the mutual aid agreements will provide greater flexibility in implementing the ERP through the provision of immediate assistance that is reimbursable at a future date and time. Since the water utility will often have advance knowledge of events, this will allow for pre-planning activities and mobilization through the activation of the mutual aid agreements. Lastly, mutual aid agreements can be negotiated in a way that allows for aid to be provided even if an emergency is not formally declared or at hand, allowing for the intertwining of the ERP and climate-resilient BP in a way that provides additional flexibility in undertaking projects and practices to achieve climate resilience.

A water utility may need to establish mutual aid agreements with the following:

- Grocery stores or restaurants for food during an emergency event
- Electric utilities or businesses for radios, backup batteries or generators
- Other water utilities for bladders, tankers, or necessary equipment or supplies
- An independent laboratory or another water utility for water quality testing

As the management staff develops and assesses the initial ERP, it will be important to ascertain what additional aid agreements may be necessary to provide additional flexibility and efficiency in the implementation of the ERP.

EXAMPLE: ISAWAD

ISAWAD MUTUAL AID AGREEMENTS

PARTNERS	MUTUAL AID ARRANGEMENTS	AUTHORIZED REPRESENTATIVE, ADDRESS, AND CONTACT INFORMATION
WATER DISTRICTS		
ZAMBOANGA CITY WATER DISTRICT	Loan or grant of emergency repair materials, water treatment supplies, and other emergency supply requirements Deployment of various equipment for repair or operational needs, i.e. water tankers, portable laboratory, pipeline construction and repair equipment. Deployment of technical personnel for critical operational requirements and other competent personnel for other emergency manpower requirements.	**GM LEONARDO REY D. VASQUEZ** Pilar St., Zamboanga City
LAMITAN CITY WATER DISTRICT		**GM AURELIO P. QUIR** Oval Road, Lamitan City Basilan Province
MALUSO WATER DISTRICT		**GM SALIE D. FRANCISCO** Townsite, Maluso, Basilan Province
PHILIPPINE ASSOCIATION OF WATER DISTRICTS	Technical assistance from other water districts to be requested through the association	**GM ALMA ABRASALDO** President

PARTNERS	MUTUAL AID ARRANGEMENTS	AUTHORIZED REPRESENTATIVE, ADDRESS, AND CONTACT INFORMATION
MINDANAO ASSOCIATION OF WATER DISTRICTS	Financial assistance through loan or grant for water district response and recovery activities Financial and material assistance for water district personnel affected by the emergency/disasters	**GM EDWIN V. REGALADO** Chairperson
WESTERN MINDANAO WATER DISTRICTS ASSOCIATION		**GM ALELI C. ALMODOVAR** Chairperson

c) WATER DISTRICT INFORMATION

A detailed inventory and overview of the infrastructure and makeup of the water utility is vital in providing staff and participating partners with the specific information necessary to effectively and efficiently respond in the event of an emergency event. The relevant information provided should include:

Water System

This is a general description of the water facilities, raw water sources, pumping facilities, major pipelines, distribution system and treatment processes. It is vital that the ERP contain as many maps, diagrams, and schematic details as possible so that anyone implementing the ERP can identify and rapidly assess and repair/replace breaks or failures in the system. This information should be updated on a regular basis (at least annually and whenever additional infrastructure is constructed in the system). Additionally, it is important to have localized information available at individual locations with copies available at other locations to allow for redundancy within the ERP process.

EXAMPLE: MCWD

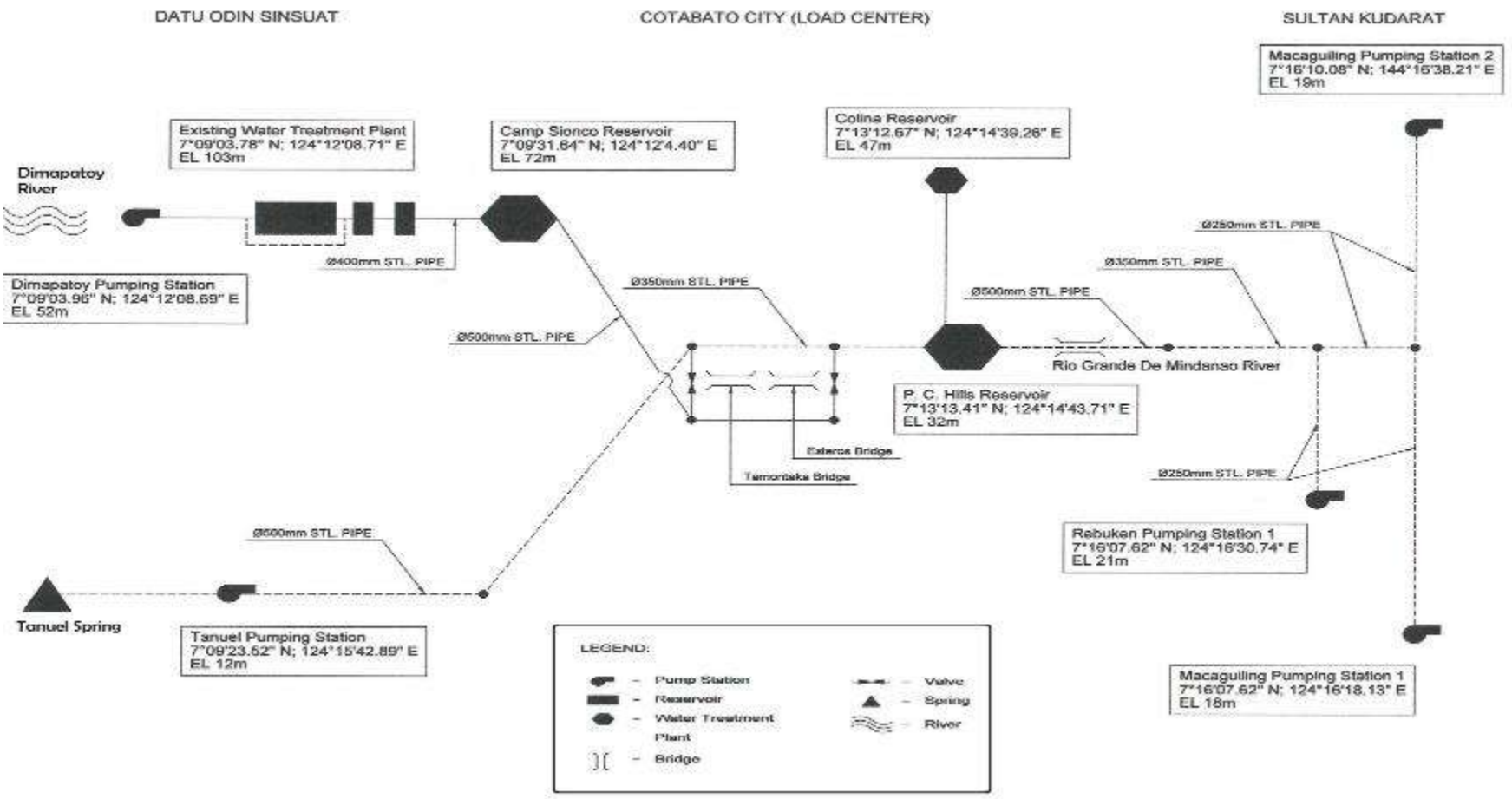
Water System Information

NAME OF STN.	ADDRESS	CAP.	TYPE OF SOURCE	MAIN FACILITIES	TREATMENT PROCESS	POPULATION SERVED
Tanuel TPS	Tambak, DOS, Maguindanao	200 LPS	Spring	4 sets of 100HP Vertical Turbine Pumps, 2 unit 315KVA Generator Sets	Chlorination	82, 500
Rebuken RPS	Rebuken, Sultan Kudarat, Maguindanao	30 LPS	Groundwater Deep well	1 set 30HP Submersible Pump-Motor, 1 unit 100KVA Generator set	Chlorination	12, 375
Mac. No.1 MAC1	Macaguiling, Sultan Kudarat, Maguindanao	18 LPS	Groundwater Deep Well	1 set 50HP Submersible Pump-Motor, 1 unit 150KVA Generator set	Chlorination	7, 425
Mac. No. 2 MAC2	Macaguiling, Sultan Kudarat, Maguindanao	7 LPS	Groundwater Deep Well	1 set 30HP Submersible Pump-Motor, 1 unit 100KVA Generator set	Chlorination	2, 888
Dimapatoy DPS/DTP	Lomboy-Awang, DOS, Maguindanao	140 LPS	Surface Water	4 sets 150HP Vertical Turbine Pumps, 1 set 125HP Submersible Pump-Motor, 2 set 500KW Gen.Set	Flocculation, Sedimentation, Sand Filter, Chlorination	57, 750
PC HILL PS	PC Hill, Quezon Ave. Extension, Cotabato City		Booster Station	2 sets 60HP Split Type Centrifugal Pump	N/A	

Critical System Components and Diagrams

EXAMPLE: MCWD

MCWD Water Facilities



Alternate Water Sources for Short-term Outages
The water utility, through its management team, should identify alternative water sources that can be utilized during short term outages. These sources can include bottled water, potable water from private wells, bladders or tankers trucks, or other sources. The provision of the alternative water sources should be accomplished through mutual agreements that can be mobilized prior to the occurrence of an emergency event.

Agreements with Other Water Utilities
These agreements should be negotiated with neighboring utilities and other water providers within the regional area, as they have their own water supply and treatment systems. This will enable the utilities to have uninterruptible water service capability during and after an emergency. As an example, Palm Beach County has over 10 of these agreements with neighboring cities and other water providers.

Emergency Equipment and Supplies
In addition to detailed schematics regarding the infrastructure, the ERP must include a detailed inventory of all equipment and supplies that are on hand for utilization during an emergency event. This inventory should include items such as flashlights, vehicles, computers, tool kits, radios, etc. Anything that could be utilized during an emergency event should be identified and tied to an individual or specific unit that will utilize the equipment during an emergency. This will ensure that senior management and individual units know who is responsible for what equipment. The assignment of the emergency equipment should take place at the same time as the record keeping required of staff responsible for utilizing and keeping track of the equipment.

EXAMPLE: LMWD FACILITY EMERGENCY EQUIPMENT LIST

Equipment Supply Description	*Location*	*Specific Function and Capability*	*Responsible Person/Title*	*Contact Number*	*Inventory/Restocking Frequency*
Heavy equipment					
Backhoes	Treatment Plants, Brgy. Hibunawon, Jaro, Leyte	Desilting; Debris Extraction	Pempe Quinones	09189236392	2 units
Payloader	-do-	Loader	-do-	-do-	1 unit
Dumptruck	-do-	Transport	-do-	-do-	2 units
Water tankers	Nulatula, Tacloban City	Water deliveries	Rico Novilla	09995001939	7 units
Boom trucks	-do-	Lifter and transport of heavy equipment	-do-	-do-	2 units
Transport equipment					
Passenger cabs	Nulatula,	Transport	Rico Novilla	09995001939	2 units

	Tacloban City				
Multicabs	-do-		-do-	-do-	14 units
Single cab pickups	-do-		-do-	-do-	7 units
Double cab pickups	-do-		-do-	-do-	4 units
Toyota pickups	-do-		-do-	-do-	3 units
Navarra pickup	-do-	Service	-do-	-do-	1 unit
SUV	-do-	Service	-do-	-do-	3 units
Tricycles					3 units
Single motorcycles	-do-	Service	-do-	-do-	12 units
General equipment					
Generator sets/pumps 150KVA	Nulatula, Tacloban City	Alternate Power	Ramil Pulma	09193285171	2 units
Generator sets/pumps 150KVA	Settling Basin, Dagami, Leyte	-do-	Eulogio Latoja	09266492053	1 unit

Personnel Protective and Other Emergency Equipment
The ERP should detail all established written procedures for using and maintaining personnel protective and emergency response equipment. These procedures should apply to any emergency equipment relevant to a response involving a toxic chemical, including all detection and monitoring equipment, alarms and communications systems, and personnel protective equipment not used as part of normal operations.

All procedures should detail:

- How and when to use the equipment properly
- How and when the equipment should receive routine maintenance
- How and when the equipment should be inspected and tested for readiness
- Training requirements

Recordkeeping
The ERP should establish a detailed process for signing out and documenting the use of every piece of equipment identified in the ERP. This recordkeeping process will allow the Management Team to track utilization of equipment by individual employees and create accountability for the utilization and upkeep of the equipment. Detailed record keeping will also allow the water utility to clearly establish costs undertaken during the implementation of the ERP during an emergency event.

NOTE: Many aid providers require detailed recordkeeping for any financial disbursements provided during an emergency event.

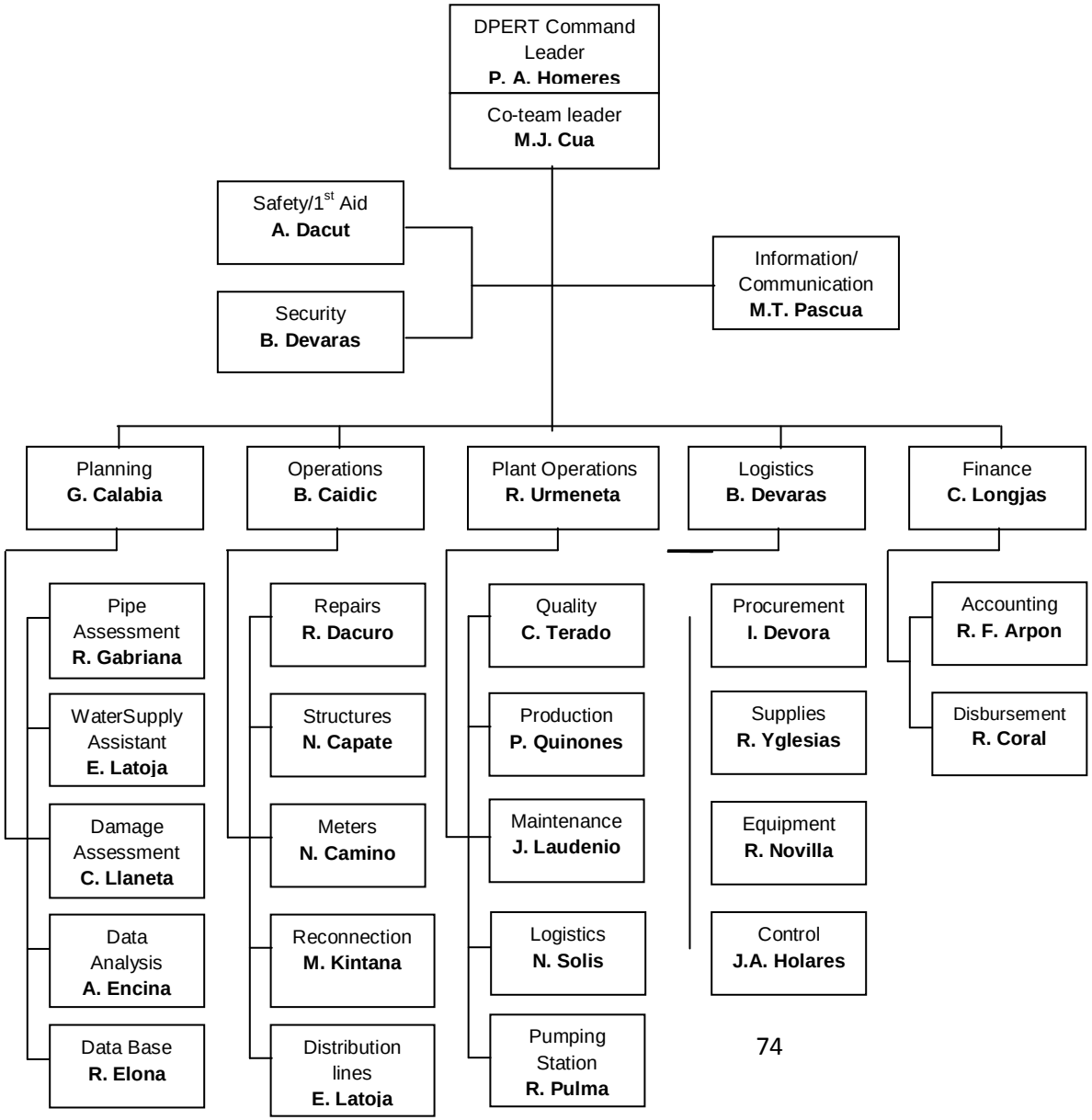
d) EMERGENCY OPERATIONS

The ERP should clearly identify the location of the Emergency Operations Center (EOC) and the procedures associated with the staffing and management of the EOC. The EOC is the central command center for emergencies and is organized per the requirements detailed within the ERP and represented as part of the organizational chart. The ERP should identify all personnel that are responsible for staffing the EOC and should ensure 24-hour coverage. The ERP should identify several teams—from those individuals responsible for preparation prior to an emergency event to those responsible for staffing during and immediately after an event, to those teams responsible for recovery after an emergency event. There will likely be overlap between the teams and may certain individuals may be required to be present during all three phases of an emergency. Other emergency operations duties that should be detailed in the ERP include:

- Conducting damage assessment
- Coordinating with all other water/wastewater utilities
- Maintaining operating procedures and a roster for all water utility emergency support personnel
- Restoring treatment plants and potable water distribution system to service area
- Ensuring adequate water pressure to maintain fire flow requirements within service area

EXAMPLE: LMWD EMERGENCY OPERATIONS

LMWD Disaster Preparedness and Emergency Response Team (DPERT)
Organizational Structure



e) EMERGENCY ACTION PLANS

The ERP should establish detailed emergency action plans (EAPs) for every known threat specific to that particular emergency. During the initial establishment of an ERP, the management team can utilize the climate change VA as the basis for an EAP, as threats have been analyzed. EAPs should contain detailed analyses, information and procedures for execution during established time periods before, during and after an emergency event (see examples below).

For example, for a typhoon event, an ERP should include activities and responsibilities at 72 hours, 48 hours, 24 hours before landfall, during the event, and post landfall, and in specific time periods after the emergency event.

An important concept to develop as part of the EAP is the 3 "W"s:
Who does What When

This simple framework ensures that the EAP contains the proper elements to describe and subscribe accountability to those who are responsible for specific actions. Additionally, the EAP should also contain specific details and procedures for the transition from an emergency footing to a recovery footing.

EAPs should contain three parts:

- Personnel procedures
- Facilities, equipment, and materials procedures
- Special notes and procedures

EXAMPLE: PALM BEACH COUNTY WATER UTILITIES DEPARTMENT ACTION PLAN

48 hours before a hurricane (Engineering Division)

Personnel Procedures

1. Inform personnel to initiate actions below
2. Review personnel assignment list
3. Obtain and sign for assigned 800 MHz radios

Facilities, Equipment, and Materials Procedures

1. At 48-36 hours, place all project contractors on notice to cease project work and secure facilities and materials on the project site. Verify safe worksite conditions. Notify contractors that work shall not resume without WUD authorization
2. At 36-24 hours, instruct all contractors to open all detours
3. Begin finalizing computer security procedures
4. Notify emergency design/build contractor of potential emergency and provide confirmed contact information to the WUD Emergency Commander.

Special Procedures, Notes, and Considerations

1. Review 24 hour action items
2. Review and ensure that all personnel, report for action immediately after the storm event, understand their assignment and have appropriate equipment available
3. Inform WUD Command Center of any available engineering personal that can be utilized to assist other divisions and sections
5. Determine and communicate WUD contact phone number(s), reporting location(s), and time(s) to report
6. Follow food-plan action items
7. Begin finalizing records management procedures
8. Document on FEMA log forms all manpower, materials used and activities performed

As for the three Ws, it is clear that the who is "engineering," the what is "as per the procedures" and the when is "48 hours before the storm."

EXAMPLE: LWMD

TYPHOON • 36 Hours before occurrence

Personnel Procedures

1. Constant information on weather updates and condition should be well disseminated by the Information/Communication Officer;

2. DPERT Command Leader makes sure personnel are available, prepared, and ready on their assigned posts/tasks;

3. DPERT Command Leader or its representative meets personnel to discuss alternatives on possible scenarios to happen;

4. Ensure alertness and presence of mind of responsible persons; and

5. Security Officer checks applicability of the Security Plan and its options.

Facilities, Equipment and Materials Procedures

1. The unit in-charge in the maintenance of equipment and facilities shall conduct checking of such;
2. Assigned technical personnel to evaluate the protection of weak areas of the structures;
3. Equipment officer ensures standby transport and equipment units;
4. Make ready tools, instruments needed during emergencies;
5. Position backups (equipment and tools) in strategic places; and
6. IT personnel checks and ensures safety of data, instruments, and equipment like computer sets, etc.

f) RESPONSE AND RECOVERY

During emergency response and recovery operations, the Management Team will appoint a Recovery Manager. The Recovery Manager is responsible for selecting a Recovery Team and developing a recovery strategy prior to emergency termination. The Recovery Manager should be a senior operations representative familiar with the systems that may be affected by the emergency. S/he will have the responsibility and authority to coordinate recovery planning; authorize recovery activities; protect the health and safety of workers and the public; and initiate, change, or recommend protective actions. Additional responsibilities may include:

- Facilitate the transition from emergency to recovery operations
- Develop, implement, and maintain the recovery plan
- Coordinate all vendor and contractor activities that occur onsite
- Ensure that the appropriate safety inspections have been completed
- Coordinate the completion of emergency repairs and schedule permanent repairs
- Notify key agencies of emergency repair status and the scheduled completion of system repairs
- Complete permanent repair and/or replacement of system facilities

Post Storm Damage Assessment

In the aftermath of any disaster such as a flood, typhoon, earthquake or other emergency, the following actions should be taken as soon as possible.

- Conduct an onsite inspection of all treatment facilities
- Check and examine the condition and operation of all process equipment
- Check for structural and other damage to facilities and chemical storage tanks
- Conduct an inspection of the plant for leaks in the piping system
- Prepare a preliminary damage report
- Report conditions to appropriate officials

g) UPDATING AND TRAINING

Plan Review

It is essential that the ERP contain specific procedures for the review, assessment and update of the BP. This review should occur at least once a year and/or in the aftermath of an emergency event. It is important to undertake a review and assessment annually after the execution of a desktop exercise. If desired, the ERP can include a detailed description of examples of desktop exercises in the Appendices.

The purpose of the review and assessment is to identify those weaknesses or additional necessary information that have been identified during the desktop exercise or an emergency event and incorporate new procedures or information to address those weaknesses. The review should be undertaken by the ERP Management Team based upon suggestions or issues identified by those teams responsible for responding to the ERP on the ground.

Review and update the ERP during these times:

- Annually prior to the annual ERP training sessions
- Upon update of the VA
- Following the ERP exercises
- Within two months of any significant plant modification or water system change
- Immediately when there is a water utility staff change where the staff member was named in the ERP
- Immediately when there is a change in the roles and responsibilities of anyone involved in response activities
- Immediately upon changes in internal and external contact information

Training and Drills

All water utility personnel who may be required to respond to emergencies will receive initial and refresher training class on the ERP. The training will be conducted annually (prior to storm season) or when any of the following occurs:

- New employees are hired
- Special emergency assignments are designated to operations staff
- New equipment or materials are introduced
- Procedures are updated or revised

The goal of a drill is to create a simulation of an emergency event where participants from the water utility are assigned roles such as communications, logistics, operations, media, and government agencies. The roles of the individual participants are meant to replicate a real-life emergency and how the individual departments and organizations interact during an emergency. The simulation should take place over a period for time, for example, one hour, where every five minutes represents one day during and after an event.

After a drill, a debriefing should be held to gauge and get feedback from the group.

EXAMPLE: PALM BEACH COUNTY WATER UTILITIES HURRICANE DRILL AGENDA

1. Hurricane Drill
    a. Activate the WUD Command Center
    b. Activate communications with PBCEOC
    c. Activate communications with FLAWARN
    d. Activate communications and reporting from each O&M Plant
    e. Activate communications and reporting from the O&M Line regional dispatch centers, including computer interface
    f. Activate communications and reporting from Customer Service Communications Center
    g. Activate communications and reporting from Warehouses and procurement section
    h. Distribute and test capability of 800 MHz radios
    i. Test all fixed plant and regional pump station generators
    j. Start and test selected skid mounted and portable generators
    k. Send sample notifications to WUD employees and homeowner's associations (HOA) using phone, fax or reverse 911 capability.
    l. Perform sample damage assessment and provide report
    m. Obtain sample FEMA forms for time and material from each organization.
    n. Utility Updates (Concurrent with other scenarios)
        i. Water tank levels
        ii. Fuel levels, approximate plant capacity on emergency generators, for how long?
        iii. Update WebEOC – Assign a specific task to someone in particular
        iv. Update Storm Tracker
        v. Show me a map or list of the location of the remotely located portable fuel tanks
        vi. Follow CEMP drill procedures (radio checks….)

2. Scenarios
    a. Scenario 1 – Server failure, no internet, no SCADA
    b. Scenario 2 – Choose an area affected by broken line
        i. Reverse 911 to this area
        ii. Isolate area (do not allow pressure drop below 50 psi)
        iii. Open all valves
        iv. Flush area
        v. Provide a report on the isolation valves (No. of turns to close and re-open each one of the valves)

c. Scenario 3 –
    i. Send one generator to Century Village, WPB (LS 0348) and provide power to their LS for 4 hours.
    ii. In addition, Zones 3 and 4 are under a power outage, provide report on how many generators are needed to be mobilized.

d. Scenario 4 – The main generator at WTP2 failed. Send a 2000 KW Generator
    i. Show up to the plant unannounced
    ii. See that they:
        1. Show you where the generator will be parked
        2. Show you where the connection will take place
        3. Have cable to connect the generator or can get it from another plant, (if from another plant go to the other plant and see the cable)

e. Scenario 5 – Laboratory was damaged. Emergency laboratory activities need to be conducted out of WTP 8. Report to WTP 8 and perform bacteriological test.

f. Scenario 6 – Watermain breaks and sewage overflows are being called in. Give 100 (45 overflows and 55 breaks) addresses to GIS and ask them to prepare a map. In addition, show 60 Lift Stations without power.

g. Scenario 7 – Simulate an actual system pressure loss in Belle Glade. See that the repump station turns on to maintain pressure.

h. Provide report of actual meal supplies ordered and where they are stored.

Appendices

The ERP should include a set of appendices that contain necessary documents providing additional information to support the main body of the ERP; templates for various forms and agreements that may be necessary prior to, during and after an emergency event; additional maps and other information; an electronic copy of the ERP and associated appendices; and any other materials identified by the ERP Management Team as necessary for inclusion. The intent of the appendices is to have all available information at the fingertips of staff responsible for executing the ERP during an emergency event.

Examples of information to be included in the appendices to an ERP:

- Staff contact list
- Organizational and staffing charts

- Action plans
- Forms
- Additional maps (flood zones, evacuation, etc.)
- Electronic copy of the ERP

LESSONS LEARNED FROM PHILIPPINE WATER DISTRICT EXPERIENCE

The threats of climate change are real. Immediate action should be undertaken to adapt and mitigate the effects of climate change on water district facilities and assets to ensure water sustainability. The development of VAs, BPs, and ERPs are critical to ensuring water sustainability. Those water districts that have already developed these plans should continue their expansion and refinement.

Drought is the major threat to many water districts in the years to come, brought about by longer dry seasons, increases demand, and gradual increase in temperature. Drought is a phenomenon that *must* be addressed in both a BP and an ERP. As drought exerts a gradual impact, BPs must incorporate projects and policies that effectively "drought-proof" the water district as dry periods increase in severity. ERPs should then include measures to address situations when drought impacts reach dire levels and extraordinary response actions are required.

Procurement laws in the Philippines are an impediment to water districts in addressing climate change. Water districts should work with PAWD representatives and legislators to amend procurement laws to allow them flexibility in the way in which calamity funds are able to be utilized. Specifically, the ability of a water district to procure a contract for disaster recovery prior to a disaster event occurring will allow for rapid response and recovery from the impacts of a disaster event.

Water districts must continue to conduct VA processes and re-evaluate planning approaches in light of climate change impacts and additional information. In conjunction with and given the realities of climate change, BPs need to incorporate and reflect adaptation approaches and projects—in other words, a climate-resilient BP. Incorporating VA results into BPs requires adjustment of financial strategy and management approaches.

Important socio-political factors may be exposed during development of the plans, which will necessitate utilization of a variety of mediation and negotiation techniques to achieve success. Enhanced intergovernmental interactions are needed that will lead to better contractual and relationship-based results, allowing water districts to have more flexibility in implementing their strategic plans and in undertaking those actions necessary to maintain and expand their systems.

CONCLUSION AND RECOMMENDATIONS

The VA, climate-resilient BP, and ERP function cooperatively to prepare a water utility for the impacts of climate change, provide a viable foundation for undertaking and funding projects and plans to develop resilience to climate change impacts and emergency events, and establish a process through which the water utility should be able to respond to and recover from a moderate emergency event with relative ease. In addition, the internal process of creating these plans allows management and staff to better understand their roles within their organizations, and to realize the limitation of their facilities, which is a valuable side benefit.

It is recommended that all these plans be revisited and updated annually. The first revisions should be implemented in 2017 and include additional water district staff in order to allow the plans to cascade through the organization, which will increase acceptance and success. Ideally, the participation of additional staff should be accomplished by workshops at the individual water district locations utilizing this toolkit as a guide.

Training and capacity building is the foundation of a successful progressive water district; therefore, we recommend continued and additional training in the following:

- VA Spreadsheet – The VA Spreadsheet was developed as part of the VAs and has evolved into a powerful analytical tool. The water districts have a basic understanding of the VA Spreadsheet methodology but additional training is needed to utilize its full potential.
- Vulnerability and risk assessment process – Several of the VAs were based on basic risk analysis plans. The next step is a more comprehensive risk assessment as part of the VA, which will refine the likelihood and impacts of climate change. The refinement of risk analysis is essential to allow a better understanding of which risks will become priorities.
- Negotiation and mediation – These include best management practices in setting up and negotiating PPPs, including the development of contractual documents regarding infrastructure transfer, financing, operations and maintenance, and reinvestment into refurbishment and replacement. Utilizing tested and effective negotiation and mediation techniques, these strategies and training are vital in negotiating with local, regional and federal stakeholders, as well as joint ventures/PPP that benefit the water district, concessionaires and stakeholders, without resulting in oppressive rates or low-quality service.
- Public outreach and communications – These should be undertaken to better communicate the impacts of climate change, results of vulnerability analysis and fiscal realities, etc. Development of an effective narrative and communications strategy is often the difference between achievement of a funding or project goal and failure to achieve that goal.

As the fiscal strains of climate change affect water districts, climate change adaptation must be included in planning and budgeting for a water district. Viable BPs must be developed and must be assessed annually and rearticulated every five years. The establishment and regular evaluation of the three plans should provide ideas and additional inclusions as the water utility becomes more sophisticated, thereby making it better poised to address resilience and climate change impacts.

APPENDIX: ELEMENTS OF AN EFFECTIVE CLIMATE-RESILIENT BP

Executive Message
The Executive Message is an opportunity for the General Manager or Chief Executive to provide his or her vision for the water utility moving forward. The Executive Message should do the following:

- Motivate staff to adopt the BP
- Explain the direction of the water utility to external stakeholders
- Describe the overarching goals and objectives of the water utility
- Describe the vision of the plan
- Explain why those certain priorities were chosen

General Description of Water Utilities
This is a management team's opportunity to provide the history, direction and key data regarding the makeup and operations of the water utility.

History of the Water Utility
The history of the water utility should describe how the organization was formed, how it expanded over time, the reasons for growth, and any ownership or structural changes that have occurred. The history also provides an opportunity to detail the political growth of the water utility as well as the historical relationship with its concessionaires. Lastly, the history should detail any significant challenges that have been faced by the water utility and how management responded to those challenges.

Answer the question: "How did we get to where we are today?" This should lay the groundwork for the objectives moving forward. Any previous steps that were taken to develop resilience to the future impacts of climate change should be highlighted.

Franchise Area Profile
The franchise area profile should clearly describe the following:

- Service area served by the water utility
- Areas of possible future expansion
- Type and location of infrastructure providing service
- The extent of the watershed from which the water utility obtains its water

Maps and aerial photographs are quality tools with which to provide context to the reader of the BP. The management team may decide to utilize different maps for the service area and layout/location of infrastructure and service lines, or can combine them into a single overarching map.[21] Additionally, the visual aids can contain added layers for additional information, such as map layers showing where a water utility is collaborating with an environmental resource agency to protect, restore or enhance a watershed.

[21] In areas where political instability and security are risks, general descriptions of service areas and delivery are recommended. Do not include sensitive infrastructure information that could be utilized to destabilize service provision.

The franchise area profile serves to illustrate the complexity of water delivery to the reader and can be utilized to justify project delivery or the need for additional rate increases or funding sources. The visual aids should detail those areas that will be most impacted by climate change, as well as the reasons why certain populations are located in the most impacted areas.

Statistical Performance Information
Information regarding the statistical performance of the water utility should include insight number of customers served, average customer use, amount of NRW, success in collections, etc. If applicable, the information should also include future demand projections and other statistics that highlight anticipated impacts that can be attributed to climate change (for instance, increased demand during certain periods due to the higher temperatures and increased drought conditions that will likely invoke increased rationing).

While information is important, management should be mindful to include only information that shareholders will find useful as too much information can overwhelm the reader and become ineffective.

Governance Structure
The BP should include details about the governance structure of the water utility so that stakeholders have a clear idea of who they can contact regarding a particular issue. It should also identify the various teams or sub-teams responsible for the VA, incorporation of climate resilience into capital improvements and operations, and emergency management, as well as their contact information. Context should be provided regarding how information is transmitted through the governance structure and whether there are specific areas of the governance structure directly responsible for climate resilience goals and objectives.

Mission Statement/Overarching Goals
What is the current vision of the water utility? Is it future-oriented? Clear, concise and to the point? Do the goals stemming from the vision include future-oriented aspirations? One of the goals developed as part of the BP should directly address climate resilience and the stance of the water utility as it relates to climate change impacts.

Current Conditions Assessment
This assessment should be an overview of the overall health of the water utility and should include the conclusions and recommendations that were the product of the VA. Some of the elements that should be included are:

- Data: Identify the data that were collected and utilized to undertake the assessment, as well as identify areas where additional data are necessary to undertake future assessments. Describe how data were collected and reported throughout the water utility apparatus and what quality control procedures are in place to ensure the validity of the data. Those staff responsible for data analysis should be identified, as well as the purpose for which the data are utilized.
- Analysis: Include analyses of previous business and strategic plans and the success (or lack thereof) that the water utility had in meeting the goals and objectives articulated within those plans. Address previous progress in meeting goals and future areas of heightened focus in the face of significant challenges, including climate change. Identify how the outcomes of previous actions track plans and which outcomes are part of a larger focus that will be included in the current plan.
- Drivers: Identify the drivers of previous outcomes (e.g., demographics, climate, regulatory, etc.) and anticipate future drivers. This will allow for more detailed explanation for the reasons to prioritize certain projects, operational changes, personnel actions, or financial approaches in the face of challenges such as the impacts of climate change. The latest trends and predictions should be

researched and included in the assessment to provide context regarding the level of urgency needed in the implementation of certain aspects of the plan. This includes the latest information garnered from the climate assessment regarding the short- and long-term trend evaluations of specific anticipated impacts as a result of climate change. Some examples of future drivers to be identified and included in a current conditions assessment are:

- Increased precipitation
- Increased drought/water rationing
- Sea level rise/storm surge
- Saltwater intrusion
- Social migration/population pressures
- Lack of funding/governance frameworks
- Lack of data
- Insufficient progress metrics
- Water loss in existing systems
- Problematic water quality/flood control

External/Internal Factors

Examine those external and internal factors that benefit or present challenges to a water utility. The factors should be segregated into climactic and non-climactic factors and should recognize physical hazards and risks to the water utility. Additional factors to be examined include:

- Political/regulatory – Include factors that restrict the water utility from expanding its system, becoming financially viable, or coordinating or collaborating with stakeholders, etc.
- Financial availability – A recognition of financial reality based on the financial assessment, including any shortfalls or limitations on the ability to undertake specific climate resilience projects based on the unavailability of funds or need to prioritize other projects.
- Demand analysis – Is demand increasing or decreasing? Has there been a major adjustment in the customer base? Are conservation efforts making an impact on water utility finances?
- Water shortage/loss – What is the current rate of NRW and how are projects to address it being prioritized? Are there projects that could be characterized as normal refurbishment to address NRW that will also provide low-hanging climactic resilience benefits?
- Staff capabilities and challenges – What are the existing challenges in human resources? Are staff properly educated and trained? What are the limitations on developing competent staff? How many contract or short-term/part-time employees are required to be utilized due to political or budgetary limitations?
- Technical education and training needs – What training resources are available within the water utility? Are internships or apprenticeships available with local academies or technical schools? What additional training needs are required beyond technical ones, such as leadership training, management, negotiation and mediation, basic finance and budgeting, technological innovation, etc.

Achievement Strategies/KPIs

Develop achievement strategies in the form of KPIs for each division and sub-division of a water utility. The hierarchy and interaction of goals, strategic objectives and KPIs are as follows:

- Goals identify what the organization wants to achieve, preserve, reduce or eliminate, and represent the core priorities for the organization within the Business Plan. Goals are quantitative and associated with specific standards and performance targets in the form of guidelines.

    - EXAMPLE: In the figure below from the Palm Beach County Water Utility Department Strategic Sustainability Plan, the Overarching Goals are established and tied to the strategic objectives. The goals include focuses on aligning the workforce with the priorities of the utility, maintaining fiscal responsibility, transitioning from a growth platform to a sustainability footing, maintaining excellence in operations and technological innovation, proactive and effective public outreach, and protection of public safety and the environment. The goals are overarching and guide the strategies that are developed to achieve a particular goal.

- Strategic objectives are developed to dictate how a goal is to be achieved or implemented. While strategic objectives are more specific and targeted than the overarching goals, they articulate strategic targets on an overarching level that are then implemented through specific KPIs on the sublevels of the organization.
    - EXAMPLE: In the figure, the strategies are tied to the overarching goal, as well as to the Initiative, which represents a categorization of which area of the utility will be most impacted by the goal. For instance, under the overarching goal of maintaining operational excellence and technological leadership, one of the associated strategies for implementing the goal is to implement a comprehensive ISO 55000–based life cycle asset management strategy and program that optimizes maintenance and repair/refurbishment of the utility's assets. This strategy will then trickle down to the KPIs that will provide measurements of the success in meeting the established strategy.

- Specific objectives are then tied to KPIs to allow for assessment and accountability throughout the organization. KPIs must follow the "SMART" framework—Specific, Measurable, Achievable, Realistic, and Time-bound. Hard targets must be established to provide firm benchmarks by which a water utility can measure its successes or failures.
    - EXAMPLE: For the example of the implementation of the comprehensive ISO 55000–based asset management strategy, KPIs would be developed to ensure that the utility allocates sufficient resources to purchase the required software and equipment, establishes training KPIs to ensure that individual staff undertakes the training required to successfully implement and maintain the asset management program, and establishes KPIs to demonstrate improvement in the asset management practices of the utility in future years, such as reducing the number of pipeline breaks, improving assessment of aging infrastructure, etc.

In developing KPIs for each subdivision of the water utility, the management team should establish leadership teams within each division that include management and the highest-rated staff to provide on-the-ground input regarding those indicators that will provide the best measurement of success. Leadership teams should be established only after the goals and strategic objectives are clearly articulated and firmly established within the BP. The leadership teams should meet regularly over the course of three to six months to develop (or review and amend) specific KPIs for their specific areas. The KPIs developed should be specific and lead to progress targets to be included in each individual employee's performance plans. For example, a KPI of 95 percent satisfaction rate for the customer services department should be reflected in the requirements for a customer service employee to undertake those actions necessary to achieve that level of satisfaction. The KPIs should be presented by

the leadership teams and approved by the management team at a meeting that formally adopts them into the business plan.

The KPIs constitute the last and most significant layer of the business plan as they are the components of the plan that are closest to the individual employees of the water utility.

KEY BUSINESS PLAN ELEMENTS TO MAXIMIZE FLEXIBILITY AND EFFECTIVE AND EFFECTIVE MANAGEMENT[22]

[22] Palm Beach County Water Utilities Department Strategic Sustainability Plan: 23–24.